



LETTERS

Sir:

Again this year a technical exhibit was held as part of the Photographic Society of America 1947 exhibition of photography, and this was hung in the Oklahoma City Art Center in connection with the PSA annual convention. Because of the wide interest shown in last year's traveling print show, about 35 prints for each of two traveling print shows are being selected from the new technical exhibit, and these will be made available to groups throughout the country.

The prints are representative of the newer uses of photography in industry and science. They include many photomicrographs, a number of examples of electron micrography, and exhibits of sunspots and other astronomical studies.

These two traveling print shows will be available to PSA groups, camera clubs, technical societies, engineering societies, and other scientific organizations, for public hanging through November, 1948. The prints are also expected to arouse considerable interest from the general public, as they show the importance of photography as a research tool, and also illustrate current progress in science and industry.

Further information may be had from the undersigned, who can be addressed at 184 Malden St., Rochester 13, N. Y.

EARL R. CLARK, chairman
Exhibition Committee
Technical Division, PSA

Sir:

I should like to inform you that a copy of our film, "Shooting Stars," the amateur production on meteor observing shown at the Philadelphia convention, is being prepared. In the near future, the copy will be available for circulation among the other amateur astronomy clubs. The film, 8-mm. size, sent out on an inexpensive rental basis, runs for 12 minutes and will provide an amusing and instructive nucleus about which a program committee might construct an interesting program on meteors.

We will have full details regarding rent-

SWEDISH PLANETARIUM TO NORTH CAROLINA

An Associated Press dispatch reports that the steamer *Bloomington Victory* arrived in Baltimore late in November bringing a planetarium projection instrument from Sweden. This is to be installed in the art gallery and planetarium at Chapel Hill, N. C., erected with funds provided by John Motley Morehead, former United States minister to Sweden. The projector is the Zeiss instrument formerly operated in Stockholm, which was sold for \$100,000 to the University of North Carolina.

The INDEX for Volume VI

is now ready for mailing. Its style is similar to previous indexes, including title page; author, title, subject, and topic references. Send 35 cents in stamps or coin, or include it with your subscription renewal check or money order. Indexes to earlier volumes are also available.

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Sky and TELESCOPE

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als prepared shortly, and those groups interested may obtain them by writing to me. The sponsors of the film recall with appreciation the interest displayed by the conventionists, and they feel sure that the film will prove popular among the many amateur groups.

JESSE W. METZGER, secretary
Amateur Astronomers of the
Franklin Institute
20th St. and Benjamin Franklin Pkway.
Philadelphia 3, Pa.

Sir:

A matter which I would like to write a few lines about may be of interest to many of your readers. I have the faculty (if such it can be termed) of viewing stereoscopic pictures with my eyes alone, without a stereoscope, and I have enjoyed looking at the back-cover moon photographs by this method. The method applies to any scene, provided you have two pictures alike; and no preparation is necessary regarding the pictures. It is merely a question of the correct distance from the eye and the correct distance apart of the photos. Only part of your moon photographs can be viewed this way, but what is available is

well worth the trouble to study this way.

To start with, take the February and March, 1947, numbers, which show the crater Triesnecker near the edge of each photo. Hold the two copies about 12 to 15 inches from the eyes, one overlapping the other, so that the crater's two pictures are about 2½ or three inches apart and absolutely parallel. Then try to bring these two pictures into one, by what some people call "squinting." The two images will appear to move toward each other, and eventually coalesce, when all detail will suddenly stand up in bold relief. Be sure to keep the two copies very steady and parallel, and you cannot fail.

After you once get it right, the pictures look quite flat when viewed the ordinary way! It is remarkable how much detail can be seen the stereoscopic way, and the lunar formations are observed as through a telescope. It is quite a pleasure viewing the moon photographs this way, and it is quite harmless to the eyes, as they do not actually "squint" at all; each eye simply looks straight at each picture.

CLIVE CHAPMAN
11 Forth St., Woollahra
Sydney, Australia

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JANUARY, 1948

COVER: Up the winding road of Palomar Mountain, the 200-inch mirror nears its observatory home. Visibility and traction are poor as two trucks push and one pulls the trailer bearing the 40-ton mirror and crate; the latter is 20 feet square. Los Angeles Times photo by Al Humphreys.

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BACK COVER: Russell W. Porter's phantom sketch of the 200-inch telescope with explanatory labels in the margins. The equivalent focal lengths are 55 feet for the primary (Newtonian) focus, 266 2/3 feet for the Cassegrainian focus, and 500 feet for the coude focus at the south end of the polar axis. Courtesy, California Institute of Technology.

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PRESS PILGRIMAGE TO PALOMAR

BY NANCY R. BOLTON

Staff, Sky and Telescope

BY THE TIME our once-in-a-lifetime caravan left Rincon on the way up the mountain road to Palomar a fine drizzle of rain was falling, at points a mixture of snow and rain. It was impossible to see beyond a few feet. George H. Hall, of the Caltech publicity department, who was driving our car, had to keep his head outside the car a good part of the time even to drive at a snail's pace.

We seemed to be clinging to the mountainside, and everywhere around us this dense vapor hung. There were occasional breaks and then I was able to see below, and my heart almost stopped a couple of times when I realized what we had just passed. I always said I wanted to live dangerously, and this was it!

At Rincon, where we had stopped from 7:55 to 8:20 a.m. to check the coupling of trailer and truck, the truckmen removed a large section of the trailer to shorten the length for the curves ahead. Once started up the mountain, there was no turning back, and the 20-foot crate which held the largest eye in the world sometimes straddled the entire road, even in places

where the mountainside dropped a sheer 1,000 feet.

But in spite of the bad weather, we were up to the observatory by 11 o'clock and the mirror was unloaded by 12. The building was completely breathtaking and equally freezing, for the summit temperature was 29° Fahrenheit. Fortunately, they had two small rooms heated for the use of reporters and photographers. When the cover of the mirror crate was removed, pictures were allowed to be taken on the ground floor, but no one was allowed above the mirror. I did, however, get a peek at the mirror from the topmost gallery, thus seeing it properly before it was placed in the aluminizing tank. The coating process was to take several days.

Reporters from many papers and wire services, newsreel camera and radio men were all there, so this trip of the century was well covered for the general public. I was very much pleased to meet Russell W. Porter, who looked as though he were enjoying all the excitement.

Back in the Charlotta Inn in Escondido, where the mirror and its retinue had bivouacked for the night, I was im-



The 200-inch mirror arrives safely on the top of Palomar Mountain, rain and sleet notwithstanding. Los Angeles "Times" photo by Al Humphreys.

pressed by the kindness of the hotel people. The interest shown by everyone was as genuine as it was enthusiastic, and there is no question that Palomar is going to have an amazing effect on the growth of Escondido. Incidentally, the charm of the place is with me yet, and I shall never forget the beauty of the surrounding orange groves.

To go back to the beginning, for this writer the Palomar pilgrimage began during the day on Monday, November 17th, when I first saw the 200-inch mirror loaded onto the 16-wheel trailer which was to carry it from Pasadena. In a glass-enclosed gallery overlooking a laboratory 120 feet square, press representatives were allowed to watch the loading process. Plywood and brown paper protected the mirror surface, while the mirror itself was carried in the cell which will hold it in the telescope tube; this cell supported the mirror during the polishing and testing operations. Two I-beams in turn supported the cell, and a giant crane hoisted and moved this combination, weighing 35 tons, on the first portion of its journey—across the room to the trailer bed. The illumination in the laboratory was very intense, so no detail would escape attention. It took 45 minutes to fit the mirror to the trailer, where it was given sponge-rubber supports and bolted tightly.

The huge packing crate which was then fitted over the mirror weighed five tons, and within this were placed vibration gauges which recorded how much the mirror was being jostled during its trip. Readings from these gauges were transmitted directly to the driver's cab of the truck drawing the trailer, so at all times the speed could be kept within safe limits. At times we went 15 miles



Crossing the Santa Fe railroad tracks on the Galivan bridge, extra dolly wheels were placed under the trailer to distribute the load the full width of the bridge. The tracks are 50 feet below. International News photo.

an hour, but usually much slower than that.

At 3:30 a.m., Tuesday, the trailer began its journey of 160 miles, lengthened over the usual road distance of 130 miles to Palomar in order to provide the safest route. We threaded through the city streets behind the police cars which protected the rear of the load and did not stop until we reached the Galivan overhead bridge, five miles north of San Juan Capistrano, where the famous mission is located. This bridge, rated safe for 60 tons, is 50 feet above the Santa Fe railroad tracks. The load was jacked up and 16 extra dolly wheels were added to distribute the weight, which made 58 wheels in all, including the trucks. After the mirror was safely on the other side of the bridge we all breathed once more; the construction engineer estimated that the bridge had sagged $3/8$ inch under the weight.

On our way we went through San Marino and Temple City, Monterey Park and Bellflower, then through the outskirts of Santa Ana and down Route 101. At Carlsbad we came inland on Route 78. All along this way crowds watched, including many school children and, of course, many amateur pho-

tographers. It was a perfect day and the brilliant sun added beauty to the lush countryside. By 5:00 p.m. when we reached Escondido, our stopping place for the night, a long caravan of cars had piled up behind us, most of it a traffic jam we had created.

The mirror was parked on Ohio Avenue in Escondido, between Juniper Street and Valley Boulevard, and although automobiles could not pass through, pedestrians were allowed to get within 10 feet of the crate. Naturally, the precious load was well guarded through what proved to be a rather short night to enjoy our pleasant hotel, for we started off again the next morning at 5:22, with 26 miles to go. There was some hesitation as to whether or not to go on at all, for the weather looked anything but good. Professor Bruce Rule, in charge of the mirror at the Caltech optical shop, and Jack Belyea, head of the concern whose trucks had tackled the hazardous job of moving a piece of glass insured for \$600,000, conferred in the early dawn and decided to continue the trip.

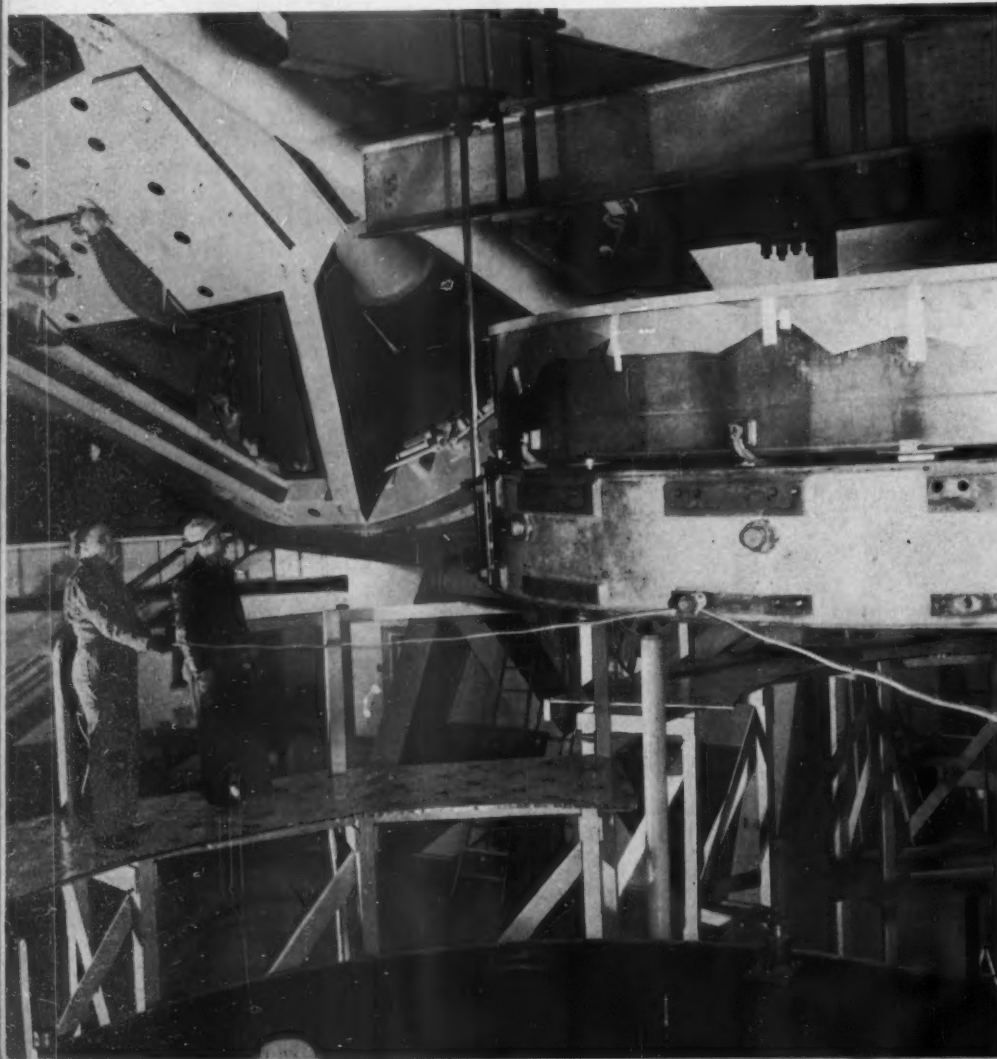
After the stop at Rincon, which I have already mentioned, the occurrence of intermittent rain, sleet, and hail

made speed more imperative, and we moved along faster than expected. At 11:02 that morning, the great disk reached the home waiting for it on the mountain. With Byron A. Hill, superintendent of construction at Palomar Observatory, directing operations, the trailer was backed through the huge 25-foot door and stopped beneath a hatch in the main floor of the building. In about an hour the packing case was hoisted off the mirror, and then it required some $3\frac{1}{2}$ hours to detach the I-beams and other supports of the mirror cell. The mirror was then hoisted clear of the trailer and the rubber cushions from the interior of the cell removed.

Finally, up went the giant eye through the hatch onto the base of the aluminizing tank. It is estimated that 36 to 72 hours will be required to pump air out of the tank and produce the high vacuum needed for the aluminizing process. Once the mirror is fastened to the telescope, adjustments and tests are expected to consume several months before regular observations can commence. Public dedication ceremonies are scheduled tentatively for May or early June.

Some miles from the top we had stopped our car for coffee at a small rustic lodge. The owner is a Polish amateur astronomer by the name of George Adamski. He had a small dome with a 15-inch telescope, and inside the lodge his interest was evident by a bulletin board with astronomical clippings and notices. I talked with Mr. Adamski, and he discussed the possibility of his building a house to contain a planetarium—probably a Spitz. This venture would surely be of interest to future visitors to Palomar Mountain.

The mirror and cell, covered with brown paper and plywood, are here being transferred to the base plate of the aluminizing chamber at the bottom of the picture. In the tube the cover over the mirror is seen, the Cassegrainian focus light shield; and the gears which turn the coude-mirror holder are at the upper left. Los Angeles "Times" photo by Al Humphreys.



IAU MEETING

The 1948 meeting of the International Astronomical Union is to be held at Zürich, Switzerland, and the dates have been announced by Dr. J. H. Oort, of Leiden Observatory, general secretary of the IAU, as August 11th to 18th. The wartime suspension of IAU meetings produced a gap of 10 years since the previous meeting, which was at Stockholm, Sweden, in August, 1938.

The American section of the IAU has decided to confer delegate status upon all American professional astronomers who may wish to attend the Zürich sessions. It is desirable that as many as possible of the American chairmen of commissions and subcommissions attend the meeting. All astronomers who intend to go to Zürich should inform Dr. Otto Struve, Yerkes Observatory, Williams Bay, Wis., so that a complete list of American delegates may be submitted to the general secretary of the IAU as soon as possible. Dr. Struve will be glad to furnish information concerning steamship and plane transportation and accommodations in Europe.

What Do Astronomers Expect of the 200-inch Telescope?


BY WILLIAM T. SKILLING

THE GREAT MIRROR of the 200-inch telescope has received its finishing touches in the optical shop of the California Institute of Technology. On the 18th of November it left Pasadena, where it had been since 1932, and started on the 160-mile two-day trek for Palomar, where its observatory home 5,600 feet above the sea had been prepared and was waiting for it. The 14½-ton mirror, cushioned with rubber sponge within a huge timber case, was drawn by a heavy diesel-powered truck, which had the help of two more trucks while going up the 6½-mile winding mountain road where climbing was steepest. This steep ascent is affectionately called "The Highway to the Stars" by the people of San Diego, whose supervisors built it at an expense of about two million dollars expressly for convenience of access to the observatory, 45 airline miles from San Diego.

As in human achievement, environmental influences results. Early Spaniards named the mountain *Palomar*, dovecot, because of its many doves. A tree-covered mile-high plateau with no precipitous slopes near the dome makes an ideal home for a telescope as well as for doves. It helps to prevent sudden and marked changes in temperature and air currents that might cause uncertain flicker of images. The vegetation and width of the mountain's broad top make the location similar to that of the Lowell Observatory in Arizona, so famous for its good seeing. Already, several years of successful experience with the 18-inch Schmidt telescope near the 200-inch dome strengthens the expectation of good seeing at Palomar.

By the way, the euphonious name that has come down to us as *Palomar Mountain*, rather than the more abrupt Mount Palomar, as sometimes wrongly used in print, is more pleasing to the astronomers who will work there, members of the staffs of Caltech and of Mount Wilson Observatory of the Carnegie Institution of Washington, and to all who are familiar with local geography.

The first thing to be done with the mirror after reaching the observatory was to enclose it in the giant vacuum chamber for treatment with vaporized aluminum, to give it the silver-like re-



A portion of the plateau of Palomar Mountain showing the dome of the 200-inch telescope, with the 18-inch Schmidt camera dome in the left center background. Photograph by California Institute of Technology.

flecting surface that will feed starlight into the camera or spectrograph. But what do astronomers foresee as achievements of this telescope of great expectations, as Dickens might have called it?

Our first information comes from decisions already made concerning uses to which the instrument will be put. The observatory council's word on this point sounds like a paraphrased form of what David Starr Jordan was told by his board of trustees when he was called as the first president of Stanford University: "Don't do anything that you can hire done." The 200-inch instrument is not to be used for anything that a smaller telescope can do. Its time will be jealously guarded for hunting big game of the universe.

It is probable that many people are expecting more of this long-heralded telescope than astronomers are. Those who will use it do not anticipate sudden and startling discoveries overnight that will be headline news in the morning paper. Discoveries will not tread on each other's heels as they did when Galileo turned his small telescope on Jupiter, Venus, and the moon. Research work nowadays bears fruit slowly.

To arrive at some idea of the expected performance of the new telescope it has been customary to compare it with others, especially with the 100-inch telescope at the Mount Wilson Observatory, which is the one nearest it in size. The Palomar mirror, being twice the diameter of the 100-inch reflector, has four times as much surface, hence four times as much light-gathering power, which will be its chief asset.

It is natural at first thought to suppose that with four times the light-collecting power, the telescope should penetrate

space to four times the distance reached by the 100-inch. All that is expected, however, is twice the distance. For doubling the distance of a star makes it only one fourth as bright, thus requiring a telescope to gather four times as much light to make the star as bright as at the shorter distance. Since volume, however, depends on the cube of the distance, the two-fold range of the telescope will bring into view a volume of eight times as much space.

According to estimates made by Edwin Hubble and his co-worker, Milton Humason, the 100-inch telescope photographs extragalactic nebulae (galaxies) that are 500,000,000 light-years away. The 200-inch mirror should double this distance, showing nebulae that are an even billion (1,000,000,000) light-years from us.

Similarly, when the giant telescope is used in the study of dwarf stars near us in our own galaxy, the number of such stars observed will be about eight times as great as the comparative few that can be studied satisfactorily with the 100-inch telescope. Also, those stars of this interesting class that are near enough to have been studied already can be much more satisfactorily examined with the larger instrument.

Those who will use the new telescope do not expect much from the increased resolving power, that is, from its ability to produce smaller images that can be better separated by magnification, which would enable better study of close star images and fine details on the surface of a planet or in a nebula. For the size of the tremor image due to the unsteadiness of the air may usually be larger than the diffraction pattern of the image.

Microscopists have avoided large dif-



A cutaway drawing by Russell W. Porter of the vacuum chamber for aluminizing the 200-inch mirror. The entire tank is divided horizontally into three sections, one below the mirror and containing the cell, the second around the mirror's periphery, and the topmost portion containing the heating elements and the mirror's surface. The operator is shown working a manual control to fire separately each of the individual tungsten filament units that carry the small aluminum horseshoes, which are so distributed over the ceiling of the bell jar that the coating on the mirror is of an even thickness. Caltech photograph.

fraction disks, and thereby have been able to run up useful magnifying power and ability to resolve images, first by using the shorter-wave ultraviolet light. This increased magnifying power is possible from about 1,000 diameters to 2,000. Then, with the electron microscope, they have been able to increase to more than 50,000 the magnification of their well-resolved images so as to see organisms not visible with light. But they do not have several hundred miles of atmosphere to contend with, as astronomers have.

Nevertheless, one of the accomplishments hoped for from the Palomar telescope will be an *occasional* instantaneous photograph of Mars. The light of Mars is strong, but it is reduced by the necessity of employing a yellow or red filter in order to make use of the wave lengths that can best penetrate its own atmosphere. Thus, time exposures have always been necessary and atmospheric tremor

smears out such details as the so-called canals, which have been seen visually by many observers.

Edison Pettit, of the Mount Wilson Observatory, who has published sketches from his visual observation of Mars, estimates that, with the increased light the large telescope will give, photographs through a yellow filter can be made in $1/60$ of a second. Dr. Hubble, who is chairman of the Palomar research committee, believes that by taking many pictures on movie film some of them may happen to be made "at the end of a flicker of the image—when it is momentarily at rest as it reverses its direction" and that a small percentage of them may show what the eye can see. One such picture might make a photographic finish of the perennial argument as to the reality of the criss-cross markings on Mars.

Of perhaps more general interest

among astronomers will be the results that are expected of Palomar in carrying farther among the extragalactic nebulae the work that has been done with the 100-inch mirror. Dr. Hubble, who has widened knowledge of this realm through use of the Mount Wilson telescope, feels confident that the greater depth of penetration will settle the question as to whether or not the red shift of nebular spectral lines is a true Doppler effect.

This apparent outward motion of distant galaxies is the observational foundation upon which is based the theory of an expanding universe. Assume the apparent recession continued unchanged to distances twice those that have been spectroscopically examined with present equipment. Then, the velocities of the nebulae, if they are real as well as apparent, would be so large a fraction of the velocity of light that the brightnesses would be reduced measurably, Hubble estimates by 40 or 50 per cent. Fewer photons are received from a receding light source in proportion as its velocity is a fraction of the velocity of light. If the nebulae are not dimmed by this cause, the red shift can no longer be used as an argument for an expanding universe, and some other explanation for this effect will have to be sought. Other causes have already been suggested, or perhaps we should say imagined, for the Doppler effect is the only one with experimental evidence.

Another outstanding advantage of the Palomar telescope's power to collect light will be evident when it is used in spectroscopic work on dim stars. If a star is so faint that its entire light must be focused at a point to make it visible, it is obviously useless to try to spread this light out into a set of lines that will reveal the nature of the star. With a four-fold accession of light, a four-fold lengthening of the spectra of dwarf stars and of stars dimmed by distance will give the astronomer a double range in which to employ his spectrograph, and therefore eight times as many such stars of which he can get readable spectra. Already, spectra of extragalactic nebulae have been made out to distances of nearly half of the 500 million light-years to which dimmer ones can be photographed. Such spectrographic study of other galaxies will be extended with the Palomar telescope just as it is to be extended among the stars of our own galaxy.

Will the new telescope simply add quantity to the known universe, or will it add, also, quality? Will it help to tell what *kind* of a universe we live in?

One astronomical question on the quality of the universe is: How much of each element is found in the make-up of stars? There is some indication that as many as 99 per cent of the atoms of the universe are hydrogen atoms. At least a third, by weight, of the material in the sun seems to be hydrogen. But the sun

is the most easily studied object since its almost unlimited light permits its spectrum to be drawn out to such a length that the spectral lines are well separated; even the visible part of the solar spectrum can be lengthened to as much as 50 feet. The most powerful spectrographs give only about three-foot spectra of the brightest stars, and spectra about a foot in length for the dimmest naked-eye stars (6th magnitude). With four times as much light from the 200-inch mirror, these lengths of star spectra should be made four times as great, and their lines correspondingly separated and made easier to interpret. This interpretation leads not only to the identity and abundance of the atom making any line but also to the conditions of temperature and pressure in the star.

Astronomers are looking forward to the better spectra that the large telescope will give with high anticipation that they will lead to answers to two fundamental questions: the sort of atomic changes that keep the stars hot, and whether in the process of these changes are built up the atoms of the various elements. The set of atomic changes announced by Bethe and known as the carbon cycle seems to account for the heat of the sun and of stars that are similar to it; and at the same time it accounts for the building up of the helium atom. But some stars would seem to require a different process, and no explanation has come forward to account for all of the elements.



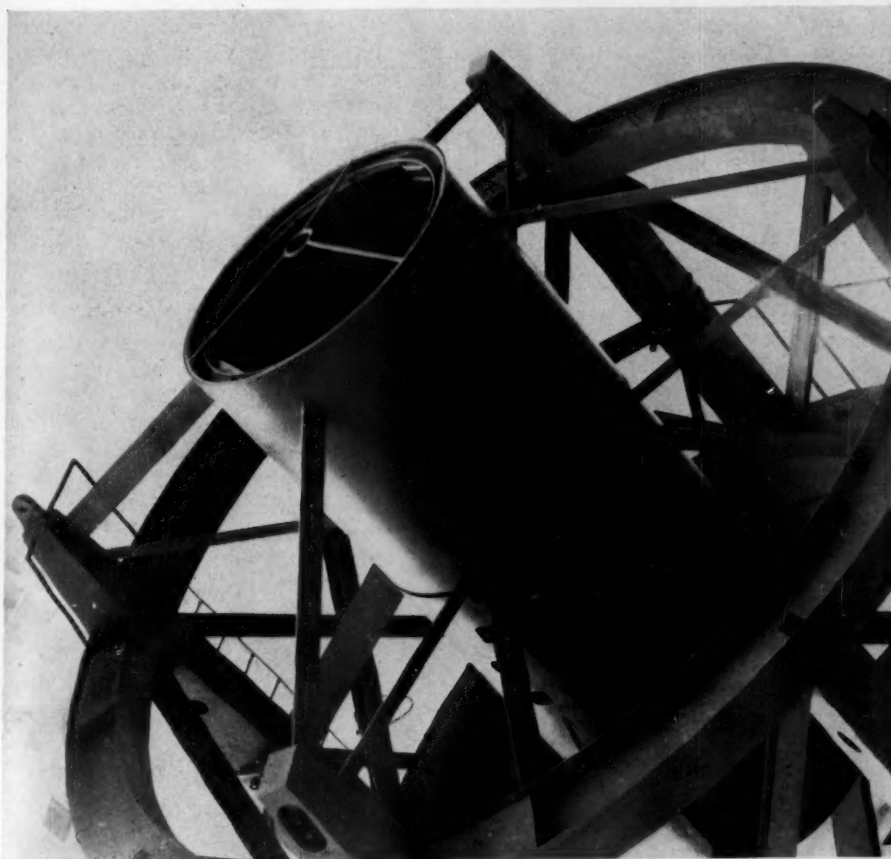
The dome of the 200-inch telescope. Photograph by Stanley E. Wright.

It is hoped that more and better stellar spectra will show whether or not the stars all have the same proportions of the elements. Are white-hot giant stars like red dwarfs chemically, or do the so-called hydrogen stars have a superabun-

dance of hydrogen? With better knowledge of the composition of stars and conditions in them it will be easier to say what is their source of energy, and whether all atoms are built up from hydrogen, as helium seems to be.

In appraising the results to be expected of the world's largest telescope we should keep in mind that no telescope is an end in itself. It merely gathers and focuses light for the astronomer to use in various supplementary instruments in his search for different kinds of information. The combined harvester is the acme in food production, but it does not put the food on our tables ready for use. Between its work and the consumer's palate the wheat must go through certain processes at the mill and the bakery. And light, as it comes from the telescope, is but the astronomer's raw material. He must process it into useful knowledge by feeding it into any one of several scientific devices. The light may be focused directly onto a photographic plate to get a permanent record. Its brightness may be measured in a photoelectric photometer, the temperature of its source in a thermocouple or a bolometer. In a spectrograph, the most useful of all these instruments, the light may be analyzed into its wave lengths.

Seldom will the 200-inch telescope be used visually to secure instantaneous information, and either the telescope or its accessories alone would be of little special value. With the aid of the secondary instruments, astronomers hope to convert the additional light that the great telescope will give them into food for the world's natural appetite for knowledge of the universe.



A close-up of the prime focus tube, which is large enough to carry the observer inside. Photograph by Stanley E. Wright.

NEWS NOTES

BY DORRIT HOFFLEIT

THIRTEEN COMETS IN 1947

A 9th-magnitude comet found by Japanese amateur Honda in November has brought the number of comets discovered in 1947 to 13, with about a month to go as this is written. This equals the all-time yearly record set in 1932. Comet Honda passed nearest the sun about November 12th, and is growing fainter, and of the other 12 objects only Comet Bester holds promise of being an interesting naked-eye object, possibly reaching 3rd magnitude in March or April, as described on page 52 last month. Comet Bester will not, as one news service story has unfortunately put it, remind old-timers of Halley's comet — except by unfavorable contrast.

FOURTEEN COMETS IN 1947!

Added in press: On the night of December 8th, a comet variously described as from 2nd magnitude to exceeding Halley's comet in brightness was seen by observers in the Southern Hemisphere in the western sky after sunset. Various reports placed the length of the tail from 10 to 25 degrees, and Dr. Richard Woolley, director of the Commonwealth Observatory, Canberra, Australia, was quoted by the press as estimating the length of the tail as 40 to 50 million miles. He also thought there was a possibility the earth might pass through the tail.

The position of the comet from December 8th to 10th apparently made it impossible to observe it in most of the United States; Dr. E. F. Carpenter, of Steward Observatory, Tucson, Ariz., failed to find it with binoculars the night of December 10th. At present, positions of varying accuracy have been received from New Zealand, Australia, South Africa, and South America. They are in general agreement with the following positions, which are reported by the Associated Press as having been made by W. L. Clapham, of the Victoria Astronomical Society: Dec. 8, $18^h 06^m$, $-35^\circ 8'$; Dec. 9, $18^h 23\frac{1}{2}^m$, $-35^\circ 20'$; Dec. 10, $18^h 42^m$, $-35^\circ 29'$. At this writing (December 11th) there is no way of ascertaining whether or not the eastward motion will continue, nor if the comet will eventually become prominent to northern observers. The first two observations above were made at 10:45 GCT, and the last at 11:05 GCT.

One press account said that at Auckland, New Zealand, observers "easily saw the comet's orange nucleus and the brighter portion of its tail at 8:30 p.m. [December 10th]. The tail extended vertically from the horizon and as the

twilight waned it spread like a plume.

"Observers in Melbourne who had field glasses said the comet had a bright head and long spraying tail, which appeared with the setting of the sun at 8 p.m. and seemed to gain brightness at intervals.

"To the naked eye at Melbourne it was only a narrow smudge of light. It began to fade at 9:15 p.m. and could not be seen 45 minutes later."

FIVE MILLION PICTURES A SECOND!

Solar physicists may eventually profit from new developments in practical optics reported from the University of Rochester. Dr. Brian O'Brien and his associate, Gordon G. Milne, have developed a motion picture camera capable of taking 11 million frames per second but normally operated at five million, which is 10 times faster than any earlier camera. If pictures taken of a rifle bullet in flight are projected at the ordinary speed for motion pictures, the bullet appears to move only one inch a minute.

To obtain the high speed without blurring the pictures badly, a device is used for dissecting the image so that one rectangular picture consists of a series of very narrow strips ($1/1,000$ millimeter wide) recorded on film traveling 400 feet per second. Reassembling the strips of the negative by a similar optical system produces ordinary 16-mm. film magnified about 10 times from the original image. Definition is sacrificed for speed, but the advantage is great for evanescent phenomena.

RADIO WAVES FROM THE SUN—A CORRECTION

In our note on Radar and Radio in Astronomy just a year ago, we unaccountably misrepresented the conclusions of Professor M. N. Saha, of the University College of Science, Calcutta. In two notes in *Nature* (Vol. 158, pages 549 and 717, 1946) he states, "It now appears extremely probable that the radio waves observed can be emitted only by the sunspots." In calling this to our attention, Professor Saha writes:

"In the note to which your original reference was made and in two more elaborate works recently published in India (*Ind. Jour. Phys.*, Aug. and Oct., 1947), I have proved from the theories of propagation of radio waves through ionospheric regions that while the *O*-component of the microwaves of meter range can only escape from the coronal layers, such is not the case for the *e*-component, which can escape from far deeper layers of the underlying chromosphere. In fact, it is the magnetic field

of the spots which actually helps in the escape of the *e*-component, in accordance with the observation that the emission of radio waves from the sun increases with the appearance of sunspots and decays with their disappearance. The *e*-component is circularly polarized on account of the small electron concentration and small value of the magnetic field of the outer layers of the corona through which the microwave beam has to pass.

"The work proves that as the whole solar atmosphere above the lowest level of the spot is involved in the emission of the microwaves (in popular language we may say that the sunspot is a gigantic microwave station), their origin should be ascribed to the same physical mechanism which is responsible for the decay and growth of spots. In spite of several theories, we are not sure at the present moment what this mechanism is, but systematic observation of the characteristics of microwave emission is sure to throw further light on this age-old problem.

"In view of the above work, I consider the coronal origin of radio noises as very improbable. The underlying assumption is that the corona has a temperature of the order of several million degrees, but those who subscribe to the opinion ought to explain how such high temperatures are produced in the corona."

COSMIC RAY THEORY

A process by which the origin of cosmic rays would be placed in cosmic dust within a few million miles of the earth has been proposed by Dr. Donald H. Menzel, of Harvard Observatory, and Winfield W. Salisbury, director of pure research, Collins Radio Company. They described before a recent meeting of the National Academy of Sciences the effects long-wave radiations from the sun may have on "meteoric dust" as well as on various regions of the atmosphere.

Fluctuations of solar activity, associated with the turbulence of the sun's atmosphere, cause the emission of radio energy of very low frequencies which has been observed with radar equipment on the earth. Because of its long wave length, this radiation can escape from the sun, possibly causing appreciable heating of the solar atmosphere, and the million-degree temperature of the corona. According to the new theory, when the long-wave radiation strikes local clouds of ions near the earth, the ions may receive energies as great as 100 billion volts, producing showers of cosmic rays. These in turn give rise to the neutrons and mesotrons of secondary cosmic rays as they enter the upper atmosphere of the earth.

Other effects of the long-wave solar radio waves are the light of the night sky, the aurora, and certain ionospheric disturbances.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 77th meeting of the American Astronomical Society at Dearborn Observatory in September. Complete abstracts will appear in the *Astronomical Journal*.

The Ursa Major Cluster

SIRIUS, five stars in the Big Dipper, and many other well-known stars are members of the Ursa Major moving cluster, inside the present confines of which the sun is located, so that these stars are seen by us in nearly all parts of the sky. By their common motion through space and their relatively small distances these stars are identified as belonging to the cluster.

In 1939 Smart discussed the claim to membership of 136 stars. He concluded that 42 stars were definitely members, with 52 more doubtful. Now at Yerkes Observatory, Nancy Grace Roman has obtained spectroscopic parallaxes of these stars for a recheck on their cluster membership. Some stars with small proper motions, for which the data are inconclusive, have been excluded by the limits on the position angle residual of 10 degrees for definite members and 20 degrees for probable members. Now there are only 30 definite members and 21 probable members, except for stars south of -30° declination which have not been considered in this investigation.

The Ursa Major cluster has a fairly compact nucleus containing 11 stars within nine parsecs. The remaining stars are scattered up to a distance of 135 parsecs from this nucleus. The lifetime of this cluster is of the same order as that of the galaxy itself. The

Coma Berenices and Hyades clusters are included in its volume of space, while the Beehive and the Pleiades are almost within it; but in regions less than eight parsecs across in each case, these relatively compact clusters contain from 30 to several hundred stars.

Infrared Solar Spectrum

FROM THE LIMIT of visibility at about 7000 angstroms in the red region of the spectrum to about 13,500 angstroms in the near infrared, astronomers have been able to record the solar spectrum photographically. Now observers at the McMath-Hulbert Observatory of the University of Michigan have obtained complete tracings of the solar spectrum to about 20,000 angstroms. The extension of the solar spectrum into the infrared was conceived by Dr. Robert R. McMath, and carried out under his direction. In 1938, Dr. McMath designed the McGregor solar tower with the specific infrared application in mind. The installation and observations were carried out by Dr. Orren C. Mohler, assisted by Dr. Arthur Adel.

Previously, others had covered this infrared region with thermocouples and bolometers, but these had rather low sensitivity and only gross details of the spectrum were recorded. With the new apparatus, which employs as its most important part the lead sulfide photoconductive cell developed during the war by Dr. R. J. Cashman, of the Northwestern Technological Institute, the resolution is comparable with that of the photographic plate in the visual region of the spectrum. The various molecular bands in the earth's atmosphere are fully resolved, and individual atomic lines of the solar spectrum are well isolated.

The Cashman cell has a phenomenally high sensitivity in the spectral region 10,000 to 30,000 angstroms, exceeding by a factor of 100 the best present thermocouple. During the war, this cell made it possible for our troops to "see" in the dark, and it was used extensively in infrared signaling devices. The cell at McMath-Hulbert was made by Dr. Cashman, and the amplifier employed with it constructed by W. R. Wilson, the former's associate at North-

THE URSA MAJOR CLUSTER

Star Name	Constellation	Mag. (visual)	Distance (parsecs)
HD 115043	Ursa Major	6.74	1
Mizar A	Ursa Major	3.15	1
Mizar B	Ursa Major	3.96	1
Alioth	Ursa Major	1.68	1
78 UMa	Ursa Major	4.89	1
Alcor	Ursa Major	4.02	2
Megrez	Ursa Major	3.44	3
Phecda	Ursa Major	2.54	5
HD 108134	Ursa Major	7.41	7*
Merak	Ursa Major	2.44	8
37 UMa	Ursa Major	5.16	9
45 Bootis	Bootes	5.03	16
Alphecca	Corona Borealis	2.31	17
59 Draconis	Draco	5.06	17
HR 7451	Cygnus	5.65	21
Sirius	Canis Major	1.58	26
Menkalinan	Auriga	2.78	32
Beta Serpentis	Serpens	3.74	37
HR 4867	Ursa Major	5.87	48
29 Comae	Coma Berenices	5.64	61
Xi Eridani	Eridanus	5.23	64
78 Virginis	Virgo	4.93	65
76 Cygni	Cygnus	6.05	72
HR 710	Cetus	5.88	73
61 Leonis	Leo	4.97	76
HR 5214	Canes Venatici	6.57	78
HR 5373	Bootes	5.03	102
HR 8407	Lacerta	5.62	106
56 Herculis	Hercules	6.33	128
HR 797	Aries	6.27	135
(85 Ceti)			

*Data for this star is not too reliable, but indicates that it belongs to the cluster.



A model of the Ursa Major moving cluster, seen from a point 800 parsecs from the sun in a direction at R. A. 22^h and Dec. $+67^\circ$. The bottom of the model is 100 parsecs below the galactic equatorial plane. Clusters are the large rings, the Pleiades in the lower right, Praesepe in the upper right. The large balls represent giant stars. Courtesy Yerkes Observatory.

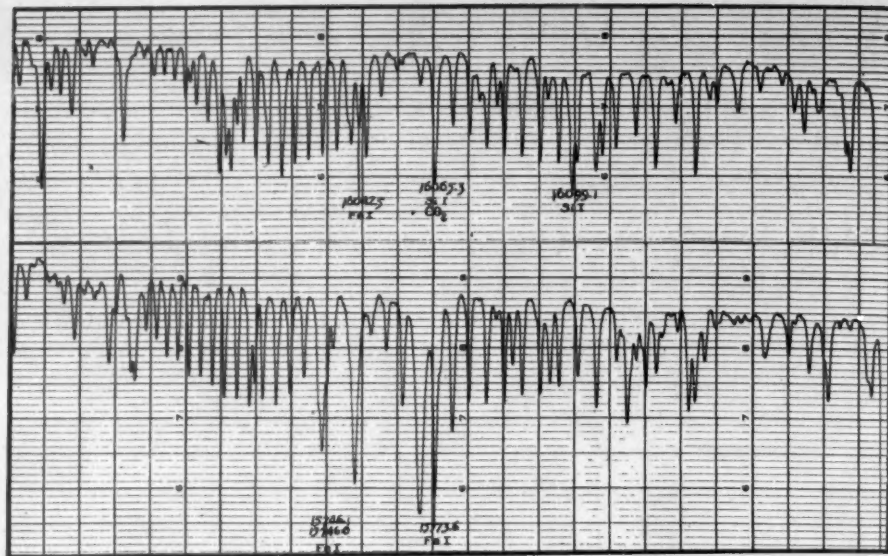
western. This summer the cell was used with the McGregor spectrograph, which has a dispersion of about 2.1 angstroms per millimeter in the first order. The cell is driven across the focal plane of the spectrograph by a constant-speed synchronous motor. After the signal has been amplified, it is used to actuate a Leeds and Northrup Speedomax recorder, which yields a direct-intensity tracing of the spectrum on paper.

Beginning at about 11,000 the solar spectrum consists mainly of bands of molecules in the earth's atmosphere, especially the oxygen band at about 12,700 and a heavy band of water vapor extending to about 15,000. From there to about 17,500, the spectrum is relatively free of terrestrial lines, and large numbers of solar atomic lines may be seen. An exception are the bands of carbon dioxide at about 15,700 and 16,000, which, although observed previously, are now for the first time resolved into their individual components. Two of four of these bands have been analyzed by Drs. Adel and Mohler.

Beyond 18,000, there is almost complete telluric absorption extending to about 20,000, the former effective limit of the McMath-Hulbert apparatus, in which the lens optics absorb longer wave-length radiation. Dr. McMath has designed an all-reflecting system which permits observations to about 40,000 angstroms; this apparatus began operation in November, 1947.

Dr. Leo Goldberg, director of the University of Michigan Observatory, reported work by his colleagues and himself on the discovery or identification of new atomic solar lines in the 15,000-16,500 region. Most of the lines identified have never been observed in the laboratory. This analysis will provide a valuable extension of our knowledge of the solar atmosphere. In fact already there appears to be a startling discrepancy between the behavior of iron lines in the infrared and the prediction of currently accepted theory.

The iron lines in the infrared are very strong and the numbers of highly excited atoms required to produce them exceed by a factor of 100 the numbers predicted on the basis of the 4800° absolute normally accepted as the excita-



Intensity tracings of two short sections of the infrared solar spectrum at 15750 and 16050 angstroms, showing the fully resolved bands of carbon dioxide in the earth's atmosphere superimposed on the solar spectrum. The lines of Fe I and Si I originate in the sun's atmosphere. Courtesy McMath-Hulbert Observatory.

tion temperature for iron atoms in the sun's atmosphere. This evidence is similar to indications already given by the chromosphere and corona that somewhere the sun is producing a great deal more energy than can be accounted for by its surface temperature alone.

The far infrared, too, has come in for its share of attention. Drs. Adel and Goldberg are studying "windows" in the sun's spectrum, particularly one that lies between 77,000 and 140,000 angstroms. In earlier work at Lowell Observatory, Dr. Adel has made observations of the solar spectrum extending beyond 200,000 angstroms. In the region mentioned above, a few lines arising from neutral atoms of potassium and sodium in the sun had been found, but in the main the solar lines were unidentified. Dr. Goldberg has now calculated that there should be many hydrogen lines of enormous intensity in this window, which calculation is in conformity with the observations. The hydrogen lines, also, have never been observed in the laboratory, as they involve the sixth and higher levels of hydrogen atomic energy states. The names of the infrared series already known are the Paschen, Brackett, and Pfund, the last arising

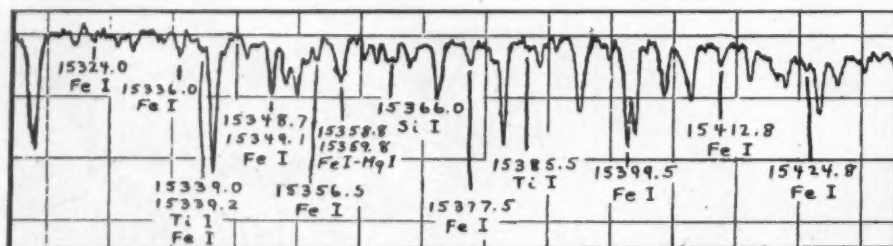
from the fifth level of excitation. As the absorption intensity of a line is proportional to the square of the wave length, Dr. Goldberg believes (other factors not considered) that this far infrared window should provide an extremely favorable region for further study of the solar spectrum.

Training in Celestial Mechanics

CELESTIAL MECHANICS treats of the motions of heavenly bodies, including the planets and other objects in the solar system, all of which are subject to the law of universal gravitation. And although this field of astronomy has in recent decades been overshadowed by the advances in photography and spectroscopy, celestial mechanics is still fundamental to all astronomy and is attaining increasing importance in problems of rocket navigation, artificial satellites of the earth, and interplanetary travel.

In a paper presented at the teachers' conference, Dr. G. M. Clemence, director of the Nautical Almanac, U. S. Naval Observatory, urged college undergraduates interested in the physical sciences or mathematics to take, in the junior or senior year, at least one course in celestial mechanics in order to become acquainted with the field as a possible lifetime project.

At the present time there is a definite shortage of scientists trained in the fields of mathematics embraced by celestial mechanics; for instance, Dr. Clemence said that for the Naval Observatory it is impossible to find the requisite number of persons properly trained for carrying out the routine work of time determination, meridian astronomy, and compilation of the *American Ephemeris* and the *Almanacs*. This means that the energy of the senior staff has to be di-



An intensity tracing of about 125 angstroms of the solar spectrum centered at about 15370 angstroms, showing atomic lines of iron, titanium, and silicon. The wave lengths were computed from the known locations of atomic energy levels established through studies of laboratory spectra in the photographic region. Courtesy McMath-Hulbert Observatory.

verted from research to training and instruction, or even to actual performance of routine tasks.

Although the applications of celestial mechanics to industry and government are limited, there exists a large demand for celestial mechanics with a doctor's degree. This demand, however, is not primarily for astronomers nor for specialists in rocket navigation and space travel, but for experts in the art of computation. Dr. Clemence pointed out that by the art of computation he meant the formulating of a problem so as to make it susceptible of numerical treatment, preferably by calculating machines, and the ability to ascertain that the result is correct.

"It may seem strange," he said, "that celestial mechanics are better at this sort of thing than are other scientists; but the experience of the recent war has shown this to be so, both here and abroad; and I can only explain it by the long tradition of computing that celestial mechanics have behind them and by the exceptionally complete training which the subject provides in formulating and solving a problem on the basis of fundamental *theoretical principles*, by a procedure that is adapted to obtaining a solution *adequate to the purposes in hand*, which is of a form adapted to numerical application with data of the character available, and which must then be put in form for *convenient practical use*."

He then stated that millions of dollars, and even lives, have been lost because competent computers were not available, and months of labor have been expended only to get a result that was wrong, when the correct one might have been obtained in a few hours. "Really expert computers can command their own price in any one of a dozen different fields."

From the standpoint of research and the development of new theory, celestial mechanics also needs more adherents. Much of its alleged difficulty lies only in the labor of calculations, which has

now been mitigated by modern computing machines. "However, the subject is difficult," Dr. Clemence said, "but this difficulty should be a challenge. . . . We do not yet have planetary theories developed that are capable of representing the motions for more than a few centuries. Practically nothing is known about the stability of the solar system beyond a few elementary oversimplified theorems which certainly are too restrictive. For the rest I merely state that during the past year I have heard specific pieces of valuable research proposed which in the aggregate, I have no doubt, might occupy 50 persons for 50 years."

The other speakers at the teachers' conference were Dr. Dirk Brouwer, Yale University Observatory, who discussed textbooks and articles useful in the teaching of celestial mechanics; Dr. Paul Herget, University of Cincinnati Observatory, whose topic was "Teaching the Computation of Orbits"; and Dr. Fred L. Whipple, Harvard College Observatory, who spoke about some unsolved problems in meteor dynamics.

Pulse-counting Photometer

A NEW photoelectric photometer which counts the number of light pulses coming from a star was described in a paper by William Blitzstein and I. M. Levitt, of the Flower Observatory of the University of Pennsylvania. Early workers in the field of photon and electron-pulse counting were handicapped by the extreme feebleness of the voltage pulses at the anode of an ordinary photocell. The RCA 1P21 photomultiplier tube, however, furnishes a strong pulse which may be amplified to operate special counters furnished by the Radio Corporation of America.

In the 1P21 tube, each electron emitted when photons strike the light-sensitive surface in turn releases from two to five secondary electrons from the first dynode (secondary surface); repetition of this process through nine stages means that a single photon of light from a star can be responsible for emission of

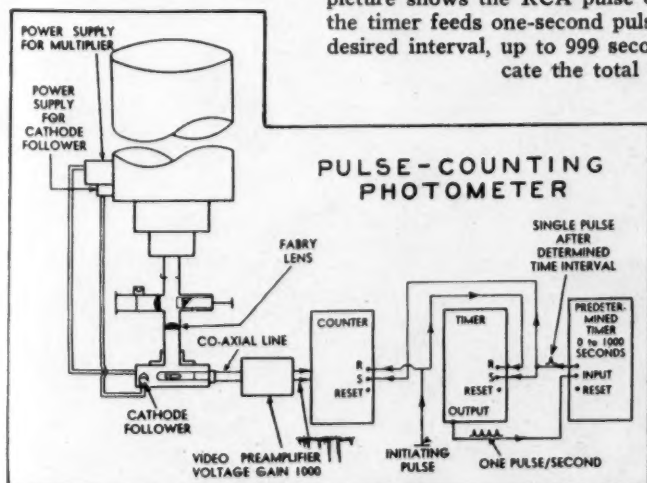
a million or more electrons from the last dynode. In 1946, bursts of this magnitude were demonstrated on an oscilloscope by Dr. A. E. Whitford, at the meeting of the AAS at Washburn Observatory, and it was then that the possibilities of pulse counting were discussed. The new apparatus was developed and constructed at the Franklin Institute Laboratories for Research and Development.

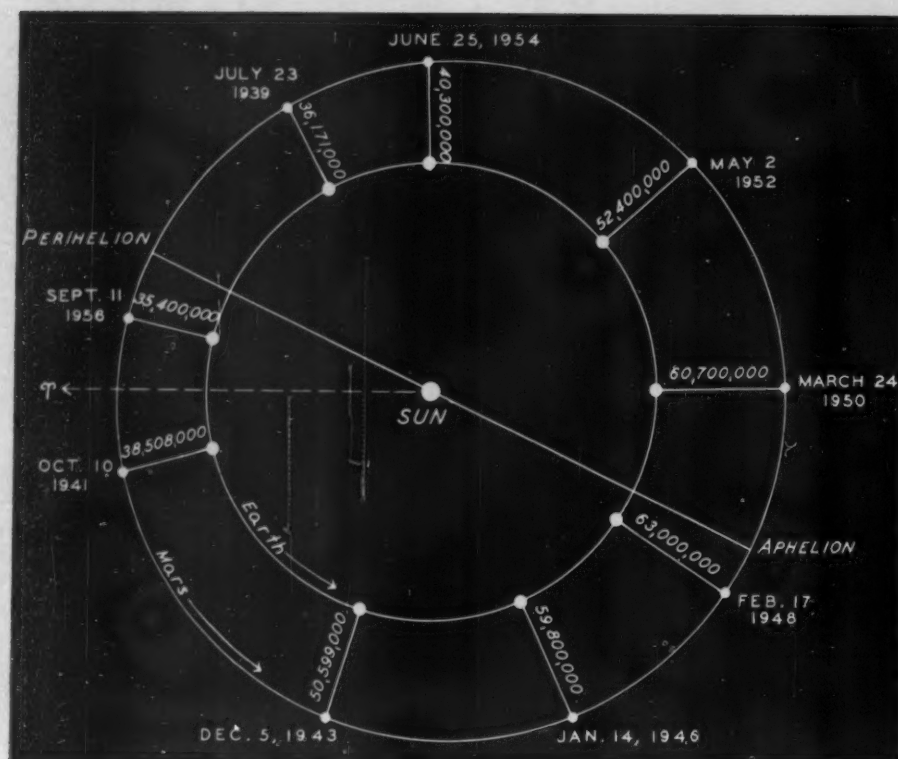
When a telescope with the new apparatus is turned on a star, light is projected onto the photometer. The tube transforms the light energy into pulses of 1/100 volt, average amplitude, and a minimum of 1/100 of a microsecond in duration. These pulses are fed into an amplifier which raises the voltage to about 10 volts, high enough to actuate the counters. The new method eliminates the inherent instability of a galvanometer in dealing with minute currents, as well as its slowness in reacting to rapid pulses.

The acquisition of an RCA precision time-interval counter makes the work completely automatic in that the observer, after setting a time interval into a predeterminer, merely pushes a button. The electronic devices then "expose" the counter to the output of the photomultiplier for a predetermined time, perhaps 10 to 100 seconds, with an accuracy of one microsecond. The number of pulses received in the interval is proportional to the light intensity of the star. Direct comparison between two stars is thus possible, and the ratio of the counts is that of the star brightnesses. From a 9th-magnitude star the pulses occur at about 88,000 per minute.

Stars as faint as 11.5 have been measured with the new apparatus attached to the 18-inch refractor of Flower Observatory, and this limit may be extended two magnitudes by improvements now in progress. Polonium is to be used as a radioactive constant for checking fluctuations which appear to be produced by irregularities in the earth's atmosphere.

The general makeup of the pulse-counting photometer is shown in the diagram at the left. The picture shows the RCA pulse counter, predeterminer, and timer. After the predeterminer is set, the timer feeds one-second pulses to the predeterminer, which stops the counter and timer after the desired interval, up to 999 seconds, has elapsed. The banks of neon lights in the counter then indicate the total number of voltage pulses received in that interval.





Mars' distance from the earth at opposition varies by about 80 per cent of the minimum value. The opposition next month is unfavorable for physical observations of the planet, for the maximum apparent diameter of the planet will be less than 14 seconds of arc.

FOLLOWING MARS

By ROBERT R. COLES, *Hayden Planetarium*

FROM a suitable vantage point in space we might picture the solar system as a great celestial race course and the planets as thoroughbreds, dashing around it in endless competition. Of course, Mercury's inside track gives him a decided advantage, but the others never give up. During the past few months the earth has been gaining on Mars and is scheduled to pass it on February 17, 1948. The fact that astronomers know just when the earth will overtake Mars robs the race of its sporting element. On the other hand, this knowledge of the laws governing the real and apparent motions of the heavenly bodies lends a fascination that cannot fail to impress us.

At its mean distance from the sun of 93 million miles, the earth travels in its orbit at about $18\frac{1}{2}$ miles per second. Mars, which is approximately 142 million miles from the sun, covers about 15 miles per second. Because of the earth's smaller orbit and greater orbital speed, it passes Mars once each 780 days. Then Mars is said to be at opposition to the sun (sun and Mars 180° apart), and it is observed to rise near sunset. When Mars arrives in that part of its orbit that is directly on the other side of the sun from the earth,

it is said to be in conjunction with the sun.

Mars was last in opposition to the sun in January, 1946. It was then visible in the night sky in the constellation of Gemini, the Twins. Rising at about sunset, Mars was visible throughout the night. As the year advanced it rose earlier each day, by the middle of February about four hours before sunset. And so it continued rising earlier and setting earlier, and by mid-July it set about $2\frac{1}{2}$ hours after the sun. Then during the remainder of 1946 it appeared steadily lower in the southwest until finally it became lost in the brilliant afterglow of sunset. On January 6, 1947, Mars was in conjunction with the sun, and thereafter moved into the morning sky, although it could not be seen until about mid-April. By the middle of June it was rising about two hours ahead of the sun. And from then on it came up earlier each night, and by December it rose nearly three hours before midnight.

During all this time Mars was observed to be continually changing its position among the stars, moving through the constellations of the zodiac. While this motion appeared generally eastward there was an interval when the planet

seemed to move back toward the west. This *retrograde* motion began a few weeks before opposition on January 14, 1946, and continued until a few weeks after that date. During the rest of its synodic period, Mars moves in a direct motion toward the east. The reason for the apparent retrograde motion is that the earth, on the inside track, passes Mars, which therefore seems to be running backward. At other times, when the earth is on that part of its orbit where it is moving in a direction nearly opposite to that followed by Mars, the planet seems to travel eastward with increased speed. When they are on opposite sides of the sun, near the time when Mars is in conjunction with the sun, the planet appears to be traveling fastest in its direct motion.

On January 9th this year, Mars again begins moving in a retrograde motion and will continue so until March 30th. Then it will resume its eastward motion.

If the orbits of Mars and the earth were exactly circular and on the same plane, their distances from each other at opposition or conjunction could be easily determined. It would be about 49 million miles at opposition and about 235 million at conjunction. But since their orbits are elliptical and on different planes, this ideal is not achieved.

While it is perfectly true that Mars is always nearer to us at opposition than at conjunction, the nearest distance may vary by about 28 million miles. Therefore, so far as the astronomer is concerned, some oppositions are more favorable than others. Because of the eccentricity of Mars' orbit its nearest approaches to the earth occur at times when it is in opposition near the time of its perihelion (on that part of its orbit that is closest to the sun). This happens at intervals of about 15 or 17 years and occurs in August or September. At the time of its latest near approach, in the summer of 1939, Mars was a little over 36 million miles from the earth.

In early September, 1956, it will be about 35,400,000 miles away, which is the nearest it has approached since 1924. Under the most favorable conditions, Mars may approach within about 34,600,000 miles, which is the nearest to the earth of any principal planet except Venus. At such times Mars' magnitude is -2.8 , which is greater than that of any star and any planet except Venus.

The axis of Mars is inclined to the perpendicular to its orbit by an angle of about 25 degrees. When Mars is at perihelion its south pole is tilted toward the sun, and this pole is therefore visible from the earth during the times of favorable opposition. When Mars is in opposition near its aphelion, the north pole of the planet is tilted our

way. This is the condition that will prevail on February 17, 1948, when it will be about 63 million miles distant.

Mars is easily distinguished from the other planets by its red color. Dr. Clyde Fisher has aptly described it as "the ruddy wanderer of the night sky." Unlike Mercury and Venus, which follow orbits inside the orbit of the earth, Mars does not show the varied phases that they exhibit. When at opposition it appears in the full phase. At certain times, it appears slightly gibbous when observed through a telescope.

This planet requires 687 days to make a complete revolution around the sun, and it rotates on its axis in $24^h 37^m 22^s.58$. Thus we see that its year is somewhat shorter than two of ours, and its day is just a little over half an hour longer than a day on the earth.

According to Russell, Dugan and Stewart's recently revised *Astronomy*: "The celestial pole for an observer on Mars would be in right ascension $22^h 10^m$, declination $+54^\circ$." This would put it in the region of the constellation Cepheus. And Deneb would be a brilliant circumpolar star in the Martian

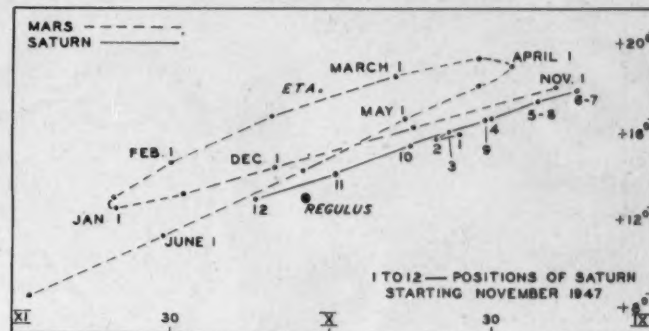
sky for observers in its mid-northern latitudes.

If you are one of those fortunate individuals who are just beginning to learn about the wonders of the night sky, this is an excellent time to get acquainted with Mars. As we approach the date of its opposition on February 17th, you may begin looking for it in the constellation of Leo, the Lion. Each night it will be rising earlier and becoming more and more prominent among the stars. You can easily pick it out by its definitely ruddy color, and observe how it appears to move against

the background of stars in the zodiacal constellations. Watch for its retrograde motion after January 9th, and then observe its return to direct motion after March 30th. Then notice how it appears higher in the eastern sky each evening as darkness falls until it eventually moves into the western sky and finally becomes lost in the afterglow of the sunset.

At its time of opposition in March of 1950, Mars will be nearer than at the February opposition of this year; its distance then will be about 60,700,000 miles from the earth.

A comparison of the retrograde motions of Mars and Saturn may be made from this chart. The star Eta is in Leo.



TERMINOLOGY TALKS. J. Hugh Pruett

OVER 100 YEARS AGO, the author of an astronomical text expressed this opinion in his preface:

"Astronomy is no study for children. Let them be employed on subjects more suitable to the state of their capacities until those faculties are more developed which will enable them to learn to conceive correctly of the celestial motions."

Today, some of us believe certain phases of astronomy are quite suitable for children, and we find many adults who are puzzled by terms frequently used in popular articles on the starry skies. We shall try here to clarify some of these bewildering terms.

Celestial Sphere

When we gaze at a full-starred sky, do not most of the stellar lights seem to be at the same distance from us? We know their remoteness is immense and various, but all appear to be attached to the inside of a gray-blue hemispherical dome, the edges of which rest on the irregular "sensible" horizon formed by hills, trees, and buildings. Since this dome is slowly carrying the stars westward—some constantly setting and others rising—we reasonably conclude that the arrangement is just as complete on the other side of the earth as on ours. There are then two domes which fit together to form a sphere. This apparent globular form of the sky, or firmament, is known as the *celestial sphere*.

Zenith, Nadir, Horizon

Let us fasten a small weight on one end of a string and tie the other end

to the limb of a tree. When all swinging has ceased, the line of the string points upward to the position on the celestial sphere directly overhead, the *zenith*; and downward to the location on the sky under the earth, or underfoot, the *nadir*. The horizon is the great circle half way between the zenith and the nadir, or everywhere 90° from each.

Celestial Meridian, Transit

The *celestial meridian* is an imaginary great circle which we may describe as starting at the south point of the horizon, curving gracefully up the sky to the zenith, tracing on down to the north point* of the horizon, beneath the earth to the nadir, then finally up to the south point again.

The *transit* of a heavenly body is its apparent crossing of the meridian, and is an important event. In our middle northern latitudes, the sun, moon, and planets make their "upper" transits (culminate) when at their highest points in the sky, which are south of the observer. The "lower" transits take place approximately 12 hours later across the part of the meridian which is under the earth. In the case of northern stars that never set, such as those of the Big Dipper, the lower transits occur low in the north when the stars are below the pole in the sky.

Celestial Poles

Let us imagine that a narrow spear of light—perhaps some finger of the aurora borealis off on an unorthodox tangent—begins to fly directly upward

from the geographical north pole at the rate of 100 miles an hour. Up and up it goes for days and months and years. After 27 million years, this gleaming tip will be as far from us as is the nearest known star, Alpha Centauri, although not in the same direction. For most purposes it could stop there, but we shall let it go on many, many times farther until it tangles with some star on the celestial sphere. There is a very faint star which appears practically in this location. This has been called "Polarissima," a stellar point almost 1° from bright Polaris, the so-called North Star. This point on the celestial sphere is the *north celestial pole*.

It may be objected that should an observer at 45° north latitude aim a luminous dart in the same direction as (parallel to) our polar auroral finger, it would not strike Polarissima (or its vicinity) in exactly the same place as seen from the earth. All the stars are so unbelievably remote that there is no detectable difference (parallax) of any one when viewed from widely separated terrestrial locations. Is the tip of a snowy mountain seen 100 miles due north of one's right eye not also seemingly due north from the left eye?

The circumpolar stars seemingly trace circles around the celestial pole daily. Even Polaris has this daily motion in a circle now almost 2° in diameter, but Polaris is so near the pole that for general purposes it may be assumed to be at that point. Residents of the southern hemisphere use the south celestial pole as we do the north pole, but there is no bright star near the south celestial pole.

Graphic Time Table

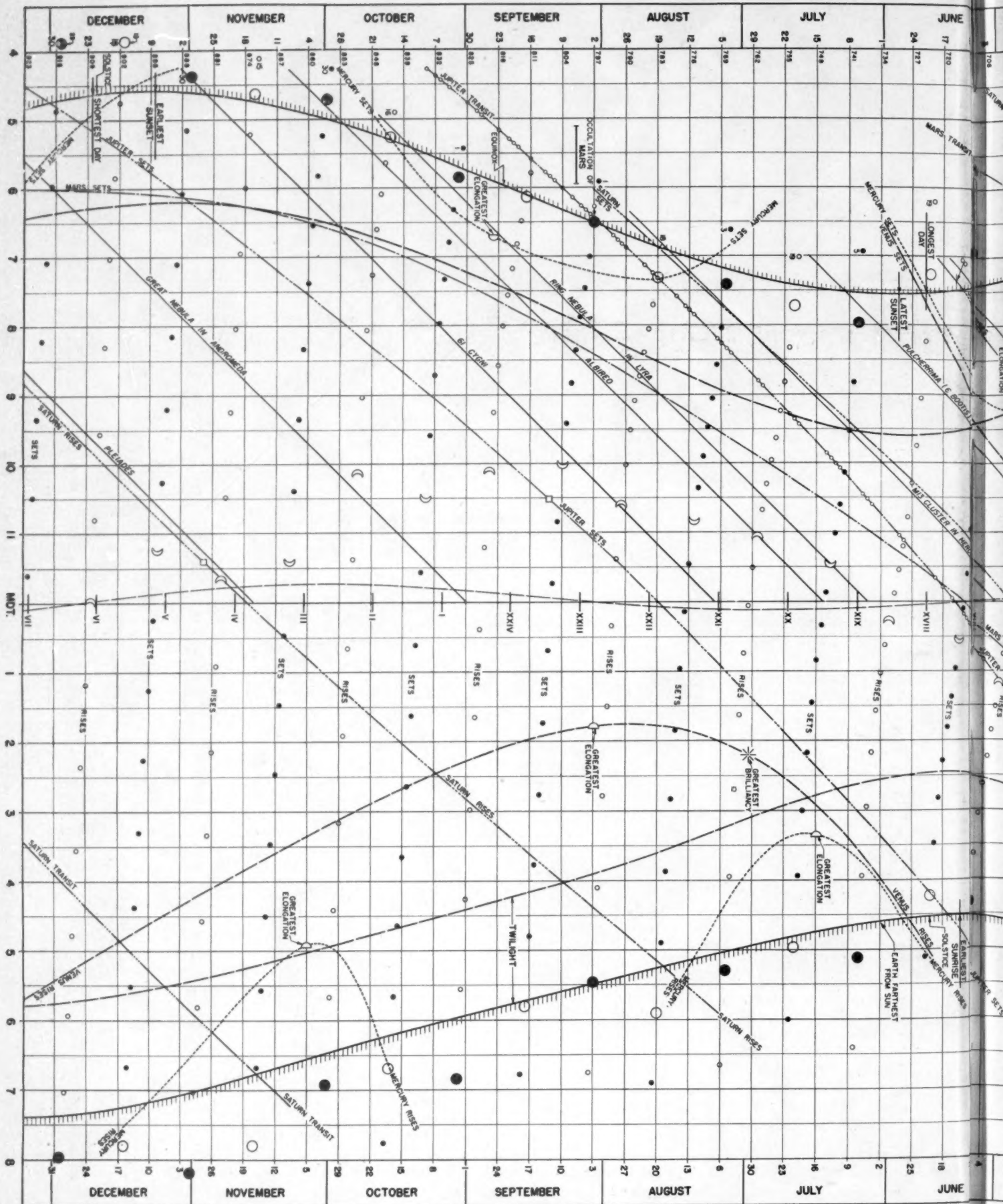
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STANDARD TIME

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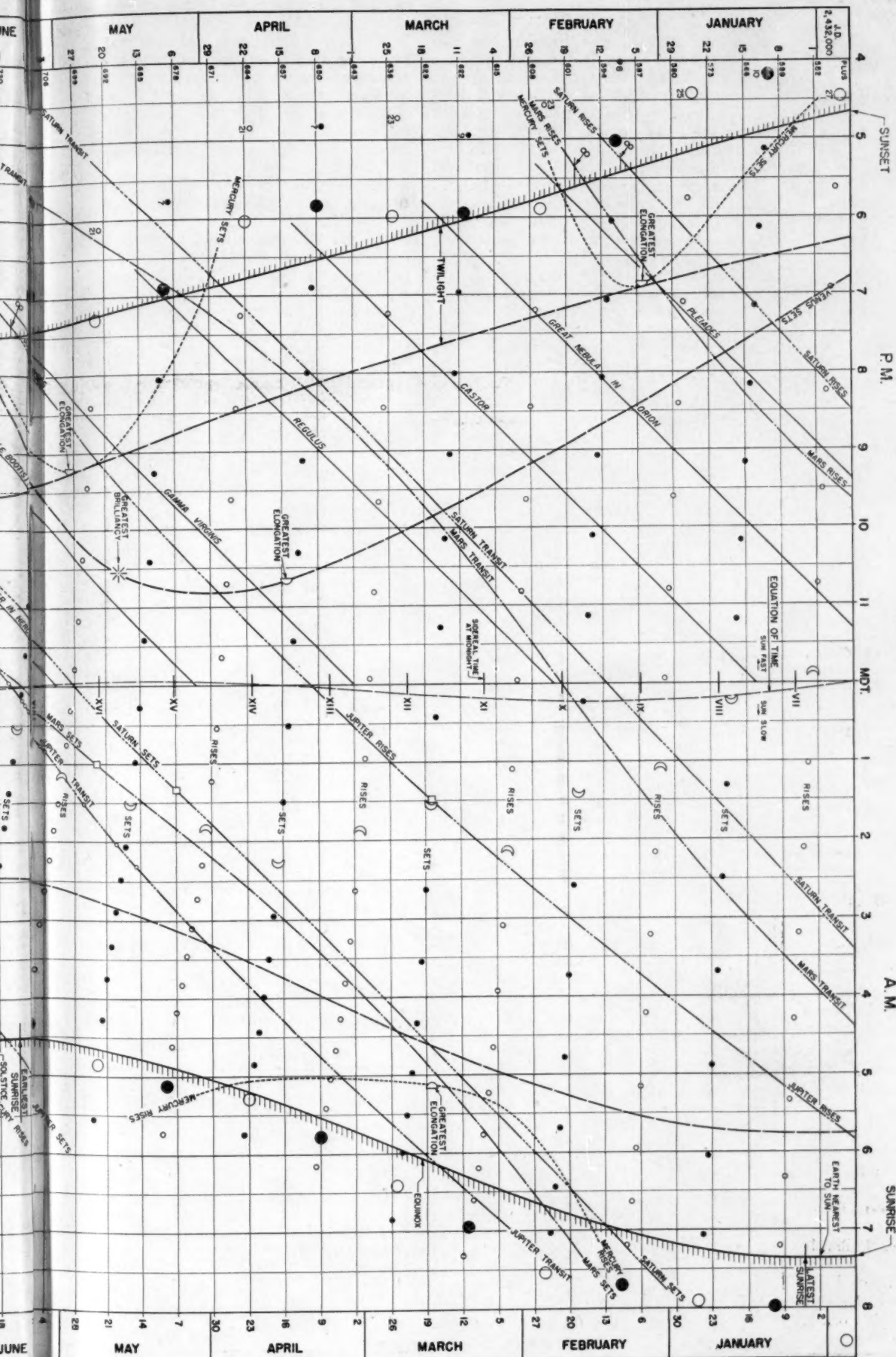
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of the Heavens - - 1948

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STANDARD TIME

YEAR 1948

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SUNRISE

The Graphic Time Table of the Heavens

while still available may be secured without charge directly from the Maryland Academy of Sciences, Pratt Library Building, 400 Cathedral St., Baltimore 1, Md. Blueprints of the original drawing before reproduction are available at cost — 75c each — 40 x 27 inches.

The Graphic Time Table gives the rising and setting times of the sun, moon, and bright planets; the beginning of morning twilight and the ending of evening twilight; the times when certain stars and other objects of interest transit (cross the celestial meridian); phases of the moon; the equation of time; and other astronomical information. To illustrate by an example: The events of the night of January 1-2 may be found from left to right. The Julian Day number for that evening is 2,432,552. The sun sets at 4:46 p.m. standard time; evening twilight ends at 6:23 p.m.; Venus sets at 7:03; Saturn rises at 7:59; the Pleiades cross the meridian at 8:55; the moon is one day before last quarter and rises at 10:43; the Great

Nebula in Orion transits at 10:50. The equation of time curve shows that the sun is slow and will not be on the meridian until four minutes after 12 o'clock noon, local time, January 2nd. Saturn transits at 2:55 a.m.; Mars transits at 3:57; Jupiter rises at 5:31; and so on.

The dashes on the sunset and sunrise curves aid interpolation on intermediate days. Roman numerals show sidereal time at midnight. The phases of the moon are indicated by the conventional symbols. Small black circles show moonset for the first half of the lunar month, and small open circles show moonrise from full to new moon. Circles on the Jupiter transit curve indicate nights on which occultations, eclipses, or transits of Jupiter's bright moons occur between 7:00 and 11:00 p.m. EST. Small squares on planet curves indicate quadrature, and oppositions are marked by the conventional symbol.

How to Correct for Your Position

As in all almanacs, times of rising and setting of sun, moon, and planets are absolutely correct for only one point on the earth's surface — for this chart: latitude 40° N. and longitude 90° W. The observer may easily correct for his own position. Latitude differences have comparatively minor effect and may in general be disregarded. Correction for difference in longitude depends principally on the observer's distance east or west of his standard meridian, which is always at an even multiple of 15°. Some corrections are tabulated here, in minutes of time:

City	Correction (minutes of time)
Atlanta	+38
Baltimore	+6
Boston	+16
Chicago	-10
Cincinnati	+38
Cleveland	+27
Los Angeles	-13
Minneapolis	+13
New Orleans	0
New York	+32
Pittsburgh	+20
San Francisco	-10
St. Louis	+10
Washington	+8

All places with plus correction are west of the standard meridian, and the events will occur later. The usual correction of one hour for each standard time zone must also be made to the Eastern standard times given for lunar eclipses and Jupiter's satellites, and in the Far West slight corrections may be made to times of moonrise and moonset. For times of occultations and solar eclipses, refer to the "American Ephemeris."

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New York 24, N. Y.

BOOKS AND THE SKY

ONE TWO THREE . . . INFINITY

George Gamow. The Viking Press, New York, 1947. 340 pages. \$4.75.

"THE BOOK originated," writes Professor Gamow in the preface to the volume under review, "in an attempt to collect the most interesting facts and theories of modern science in such a way as to give the reader a general picture of the universe in its microscopic and macroscopic manifestations, as it presents itself to the eye of the scientist of to-day. . . . The subjects to be discussed have been selected so as to survey briefly the entire field of basic scientific knowledge, leaving no corner untouched."

Even if the last words just quoted promise perhaps more than the reader may eventually find in the book, its scope is truly impressive. Its four main parts deal, successively, with various interesting points of the theory of numbers, the relativity of space and time, the world of nuclei (both atomic and cellular), and the macrocosmos. Part III—Microcosmos—forms the bulk of the book and touches in a light vein, which is characteristic of the whole text, upon a great number of diverse topics of physics, chemistry, and biology. The limelight is decidedly focused on nuclear fission, whether of atomic nuclei with all its notorious implications, or on the mitotic division of nuclei of living cells and the fundamental concepts of genetics.

The fourth part, dealing with the macrocosmos, which should be of most direct interest to *Sky and Telescope* readers, is, unfortunately, disappointingly brief. Nevertheless, it contains two features which should make it worthwhile to every amateur astronomer: a popular and readable discussion of the neutrino theory of the supernovae, and an account of von Weizsäcker's theory of the origin of the solar system.

The volume is well written and well printed. It is profusely illustrated by the author's own drawings as well as by some excellent reproductions of carefully selected photographs. A few of the drawings are really good, such as the one on page 80 depicting Albert Einstein in the role of a magician. The same disarmingly elementary style which characterized Gamow's earlier writings will accompany the reader on his kaleidoscopic journey through the present book. The occasional felicity of expression (for instance, the term "cosmic thunderclouds" in reference to the electrically charged matter in interstellar space) does much to drive home the points and to enliven the subject.

It must, however, be observed that the author's tendencies to witticisms have occasionally misled him to incorrect statements. For example, his drawing on page 5 depicts Julius Caesar attempting to write "one million" in Roman numerals on the wall. Actually, the conqueror of Gaul or any of his contemporaries or even ancestors would have known much better than to repeat endlessly the symbol M, or rather its original form (I), for this purpose. Ten thousand in Roman numerals used to be abbreviated as ((I)), and 100,000 was (((I))). It is true that by some

strange twist of mind the Roman logic stopped at that; and so when the Senate decided to erect a monument to commemorate the victory over the Carthaginians in the year 260 B. C., and to immortalize on it the amount of war reparations exacted from the fallen foes, the sculptor had to repeat the symbol (((I))) 23 times. This was a fairly laborious undertaking, to be sure, but still much less so than Professor Gamow's drawing would lead us to believe.

The misprints in the book are, unfortunately, many. Names are misspelled (Aristanchus, page 6; Schwartzschild, consistently). The reader will be surprised to learn that the prototype of the "Cepheids" is "the star β -Cepheus, in which the phenomenon of pulsation was first discovered" (page 289). The statement on page 318 that X Canis Majoris is commonly known as Sirius belongs to the same category. On pages 318 and 319, the author refers repeatedly to a star called Y 380 Cygni. I believe he means the eclipsing variable V 380 Cygni; this is an unpleasant misprint since Y Cygni, another eclipsing variable, is referred to on the immediately preceding page.

These and other misprints, due undoubtedly to hasty proofreading, are relatively a minor matter. The most serious objection which the present reviewer feels bound to raise—and in fairness to Professor Gamow it should be said that it does not concern his writings alone—is a protest against too much enthusiasm or emphasis (and omission) in presentations in popular books of theories or hypotheses which a credulous or uncritical reader may easily take for granted, but for which the cautious verdict of sober science still remains: **not proven**. Enthusiasm, even sincere and well meant, is always a poor substitute for actual knowledge; and if not used with caution it may easily help to create, in wide circles, an entirely erroneous impression about the present attainments of the natural sciences and, still more, about the rate of their development.

This latest book by Professor Gamow is by far more inclusive than any of his previous popular writings. The result is stimulating, but the dangers of attempting to cover too much in a book of limited size are likewise obvious.

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Amateur Astronomers

Norwalk Astronomy Society

The astronomical society at Norwalk, Conn., held its banquet at the Norwalker on November 8th. The speaker was David Rosebrugh, of Waterbury, Conn., who talked on "Work for Amateur Astronomers." He said that although he used the word "work," it should be called "fun." He outlined suggested observing programs; much of the work may be done with only a small telescope, some of it without one. Amateur societies in nearby towns were invited to this meeting.

Kalamazoo AAA

At the November meeting of the Kalamazoo Amateur Astronomical Association, the following officers were elected: Max Kester, president; Edgar Pashby, vice-president; Howard Bowman, treasurer; Mrs. George Negrenski, secretary. Appointments were also made to the membership and program committees. At a special meeting on December 6th, Dr. Carl A. Bauer, of the University of Michigan Observatory, spoke on "The Age and Origin of Meteorites."

Nashville Amateurs Active

The Barnard Astronomical Club, Nashville, Tenn., has resumed its regular meetings on the Vanderbilt University campus after a lapse of several years. Noted astronomers and physicists have lectured to the society, including Dr. William A. Calder, of Agnes Scott College, Decatur, Ga., who addressed the club December 11th on "Double Stars." During the past year 1,900 people visited the Barnard Observatory, which is directed by Dr. C. K. Seyfert, who is president of the society. Latimer J. Wilson, astronomer at the Watkins Institute, is vice-president.

The club meets on the second Thursday of each month. Anyone in the Nashville area interested in attending meetings of the Barnard Astronomical Club may obtain further information from the secretary, Ernie Keller, Radio Station WSM, Nashville, Tenn.

Northwest Region Organized

At a convention held in Portland, Ore., on November 7th, formal organization of the Northwest Region of the Astronomical League took place, embracing the states of Washington, Oregon, and the western half of Idaho. T. P. Maher was elected regional chairman; James Karle, vice-chairman; Margaret Edgar, recording secretary; and Charles G. Benson, executive secretary. The Portland Astronomical Society and the Portland Amateur Telescope Makers and Observers were the host societies.

There are now three organized regions of the Astronomical League: the Northeast, North Central, and Northwest, with present headquarters in New Haven, Conn., Madison, Wis., and Portland, Ore., respectively.

THIS MONTH'S MEETINGS

Chicago: On Tuesday, January 13th, J. Madison Showalter will tell the Burnham Astronomical Society of "Astronomical Truth Stranger than Fiction." The meeting is at 8:00 p.m., in the Chicago Academy of Sciences Auditorium.

Geneva, Ill.: The Fox Valley Astronomical Society, meeting on Tuesday, January 6th, at 8 o'clock in the Geneva City Hall, will hear William Siekman, of the University of Chicago, speak on "Spectroscopy."

Madison: Another of the popular symposium meetings, on sunspots, will be held by the Madison Astronomical Society at its January 14th meeting at Washburn Observatory, 8:00 p.m. The program will include observational methods, the relation of sunspots to the corona, and solar movies.

New York: "Ancient Astronomy of the Middle Americas" is the topic of the lecture by Clifford N. Anderson, of the Bell Telephone Laboratories, at the Amateur Astronomers Association. Held at the American Museum of Natural History, the meeting is on Wednesday, January 7th, at 8:00 p.m.

Philadelphia: Arthur S. Burgess, retiring president, will speak on "An Amateur Views a Solar Eclipse," at the January 9th meeting of the Rittenhouse Astronomical Society, 8:00 p.m. in the Morgan Physics Laboratory, University of Pennsylvania.

Pittsburgh: At the January 9th meeting of the Amateur Astronomers Association, Dr. N. E. Wagman, director of the Allegheny Observatory, will speak on "The Moon." The meeting is at 8:15 p.m., in the Buhl Planetarium.

Washington, D. C.: Westy Egmont, director of the World Calendar Association, will lecture at the monthly meeting of the National Capital Astronomers on Saturday, January 3rd, 8:00 p.m. in the National Museum. Mr. Egmont's subject will be "The World Calendar and Astronomy."

NEW BOOKS RECEIVED

SUN, STAND THOU STILL, *Angus Armitage*, 1947, Schuman. 210 pages. \$3.00.

The life and work of Copernicus, the astronomer, written by a lecturer in the department of history and philosophy of science, University College, London.

Planetarium Notes

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900 E. Achesah Bond Drive, Chicago 5, Ill.
Wabash 1428

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m.

STAFF: Director, Wagner Schlesinger. Other lecturer: Harry S. Everett.

BUHL PLANETARIUM

Federal and West Ohio Sts., Pittsburgh 12, Pa.
Fairfax 4300

SCHEDULE: Mondays through Saturdays, 3 and 8:30 p.m.; Sundays and holidays, 3, 4, and 8:30 p.m.

STAFF: Director, Arthur L. Draper. Other lecturers: Nicholas E. Wagman, J. Frederick Kunze.

January: AROUND THE WORLD IN 50 MINUTES. Visitors take a rapid and thrilling journey around the earth under the stars, with stopoffs at the equator and both the poles.

February: MARS AND SATURN—MYSTERY WORLDS.

FELS PLANETARIUM

20th St. at Benjamin Franklin Parkway,
Philadelphia 3, Pa., Rittenhouse 3050

SCHEDULE: 3 and 8:30 p.m. daily except Mondays; also 2 p.m. on Saturdays, Sundays, and holidays. 11 a.m. Saturdays, Children's Hour (adults admitted).

STAFF: Director, Roy K. Marshall. Other lecturers: I. M. Levitt, William L. Fisher, Armand N. Spitz, Robert W. Neathery.

January: CALENDARS AND THE SKY. In this demonstration, the astronomical basis for all calendars will be emphasized. The history of our present calendar will be told, as well as hopes for future improvement.

February: AROUND THE WORLD IN 50 MINUTES.

GRIFFITH PLANETARIUM

P. O. Box 9787, Los Feliz Station, Los Angeles 27,
Cal., Olympia 1191

SCHEDULE: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m. Extra show on Sunday at 4:15 p.m.

STAFF: Director, Dinsmore Alter. Other lecturers: C. H. Clemenshaw, George W. Bunton.

January: A PREVIEW OF THE 1948 SKY. The audience will see the principal interesting phenomena of the whole year, and will thus be prepared to understand them better when they occur in the real universe.

February: THE SEASONS.

HAYDEN PLANETARIUM

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STAFF: Honorary Curator, Clyde Fisher. Chairman and Curator, Gordon A. Atwater. Other lecturers: Robert R. Coles, Catharine E. Barry, Shirley I. Gale, Edward H. Preston.

January: A TRIP TO MARS. What is it like on Mars? The Hayden Planetarium is conducting an imaginary trip to this mysterious planet. It is an adventure strictly out of this world.

February: A TRIP TO MARS.

Sky Publications

Cosmic Rays 50c

Here is the story of the "mysterious and unseen but powerful visitors from space," graphically told, with some background in atomic physics. By W. F. G. Swann, director of the Bartol Research Foundation.

Relativity 50c

The astronomical implications of the general theory uniquely described in the language of the intelligent layman. By Philipp Frank, Harvard University.

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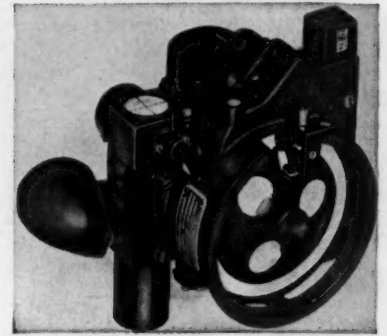
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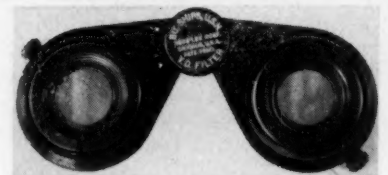
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ROY A. RENNER, of Grant's Pass, Ore. (now T/5 Renner), writes of his instrument, which was constructed by him and his father, as follows:

Mirror: 6" plate glass—1" thick; good figure, aluminized.

Mount: fork-type, semiportable. Fork is of welded steel I-beam and channel section, welded to a truck front-wheel hub spindle, and this in turn welded to a heavy

Declination axes: These were made from Model A Ford "wishbones." The balls are welded onto the telescope tube band, and they fit in their sockets, which, with adapter couplings, are welded to the ends of the fork. The arms of the wishbones are the tripod legs.

Bearings: The polar axis works on roller bearings, and has no play. The declination bearings may be adjusted for proper friction to hold the tube in any desired position.

T/5 Roy A. Renner—19277059
892nd Ordnance HAM Co.
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San Francisco, Calif.

Edward Olson describes his f/5.4 refractor:

The objective is of 2¼" diameter, and has a focal length of nearly 12¼ inches. It is fluoride coated. I turned up a cell out of wood, provided for collimation, and find such a cell entirely suitable for small lenses. The tube is of heavy cardboard, well painted, and mounted on a saddle similar to the one on Hans Pfeumer's telescope (see *Sky and Telescope*, August, 1947); the mount, however, is of the alt-azimuth type. I use four eyepieces, from 9.6x to 49x.

The performance of the instrument has been gratifying. Definition is fine right up to the highest power, and a resolving



Roy Renner's fork-type mounting and reflecting telescope.

flywheel, which includes the starter ring gear. It is intended later to use this with a suitable worm for a slow-motion drive.

Mirror cell and mounting: The mirror cell is a short length of 6" pipe with a 1" welded back-plate, with holes drilled for ventilation. The cell is threaded into a coupling, upon which is shrunk a narrow external band. The telescope tube, of 20-gauge sheet metal, is surrounded by a wide steel band upon which the declination axes are welded. A short length of pipe in front of the mirror cell slides inside the tube, and the external band fits against the wide band on the telescope tube, thus providing a position lock which permits removing and replacing the mirror without losing collimation. The steel band around the tube provides sufficient weight, together with the cell mounting, to bring the center of gravity near the rear end of the instrument.

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comments, contributions, and questions from readers.

EDITED BY EARLE B. BROWN

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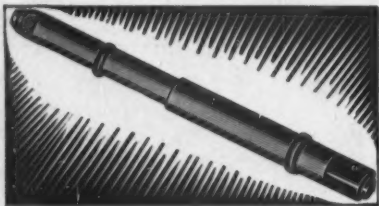
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29 mm Dia.	54 mm F.L.	coated ea. 1.25
29 mm Dia.	76 mm F.L.	coated ea. 1.25
31 mm Dia.	124 mm F.L.	coated ea. 1.50
31 mm Dia.	172 mm F.L.	coated ea. 1.25
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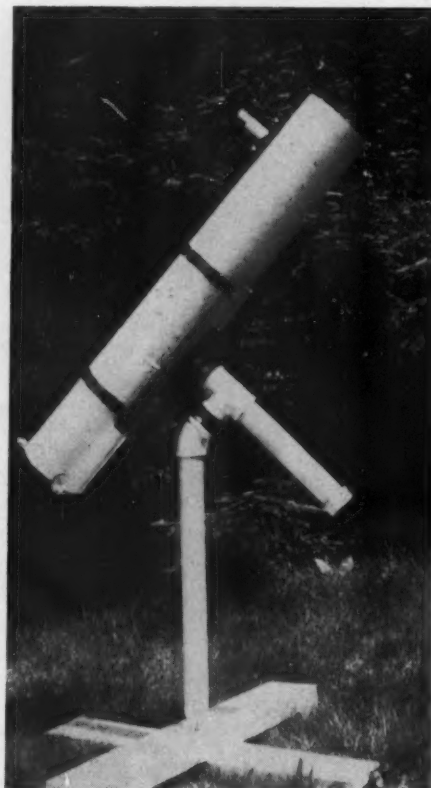
Edward Olson's rich-field refractor.

for sunspot observations, a task for which it seems well suited. It is particularly valuable for general stellar views, being nearly an RFT. At 9.6x, the field of view is five degrees, and the region of Cygnus, for example, is a marvelous sight.

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the instructions contained therein. The grinding and polishing occupied 117 hours, and I was fortunate in parabolizing easily, as it was my first mirror.

The tube is of galvanized iron; the mounting of 2-inch pipe, with a 5-pound lead counterweight. I assembled the 3x finder from purchased lenses. The mirror cell is of wood, and adjustable.

DOUGLAS CROSBY
Stockton Springs, Me.

S. F. Thorpe sends the following description of his testing apparatus, which received the second prize at the Philadelphia convention exhibition (*Sky and Telescope*, August, 1947):

The apparatus is a combination Foucault and Ronchi tester. The feature which distinguishes this from other testing outfits is the fact that the beams of light to and from the lens or mirror are separated by only 3/1,000 of an inch. When used as a Foucault tester, the same edge that forms the slit is also the knife-edge, therefore it is in perfect alignment. With this slit open wide, a small Ronchi grating may be placed over the opening. Any change of distance along the axis can easily be measured in thousandths.

S. F. THORPE
Glad-view Observatory
Route 4, Box 726
Louisville, Ky.

FIREBALL OVER TENNESSEE

An extremely brilliant meteor was seen over most of Tennessee on November 16, 1947, at 6:58 p.m. CST. The meteor was observed nearly due south of Nashville, traveling in a northerly direction. Although most reports came from untrained observers, there seems no doubt that the object moved relatively slowly and burst close to Shelbyville, Tenn.; many observers near that town heard the characteristic rushing sound and explosion made by the bursting of a meteor, and windows rattled in the vicinity. During most of its path, the meteor was many times brighter than the full moon, and at the time of the burst most observers reported it as bright as full daylight. No train of any sort was reported.

As the explosion occurred about one minute after the meteor was seen, its height at the burst must have been less than 12 miles. Its brightness suggests a mass in excess of one ton, but as yet no meteorites or crater have been found. Several near accidents were reported by motorists frightened by the brilliant flash. An airline pilot saw the explosion when he was about 40 miles west of Nashville, and it appeared so close that he abruptly changed the Memphis-Nashville course of the plane to avoid a crash.

Further observations of this meteor are highly desirable. Persons who saw it are asked to communicate with Dr. Carl K. Seyfert, Barnard Observatory, Vanderbilt University, Nashville, Tenn. Report at least the place of observation, the direction and elevation of the point in the sky where the meteor was first seen, similar directions for the point where the meteor exploded. Reasonably accurate charts of the fireball's path among the constellations are also of considerable value.

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*With the 6-inch we supply, instead of the flat, a 1 1/4" prism, silvered and lacquered on the hypotenuse surface.

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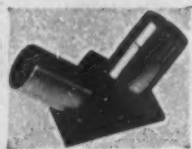
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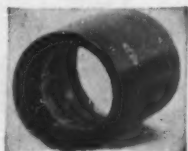
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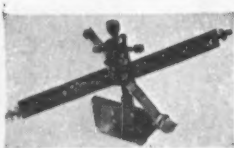
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OBSERVER'S PAGE

Greenwich civil time is used unless otherwise noted.

PARTIAL ECLIPSE REPORTS

From such widely separated points as New York City, Berkeley, Calif., and Lima, Peru, reports have been received of the eclipse of the sun on November 12th, which was annular on land only over a small portion of its path in South America.

A small group outside the Hayden Planetarium in New York, including Edward Oravec, contributor to this page, watched the progress of the two-per-cent eclipse in which as much as 16 minutes elapsed from first contact to mid-eclipse. At Little Rock, Ark., C. B. Stephenson observed with a clear sky but poor seeing. He took a series of 16 photographs using a nonachromatic 4-inch lens, f/25 at reduced aperture. Visual observations were also made, but timing of the contacts was difficult because of poor seeing.

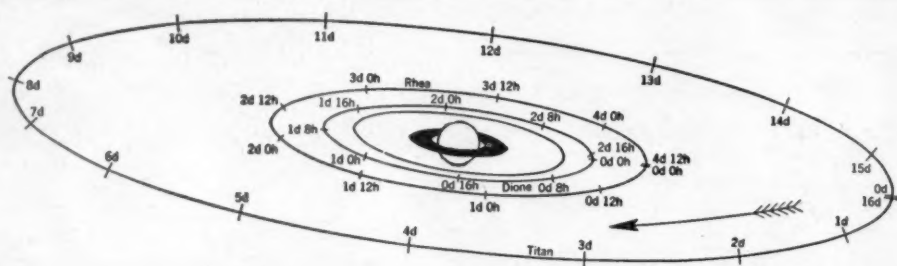
In the far West, where the eclipse was as much as 39 per cent the sun's diameter, members of the Sacramento Valley Astronomical Society made carefully planned observations. With a $3\frac{1}{2}$ -inch refractor,

six photos were secured near contact times, and during the eclipse photos were taken every five minutes on 35-mm. film. The resulting sequence of 25 frames is available to anyone willing to pay the cost of prints; communicate with L. E. Salanave, Sacramento College, Sacramento 14, Calif.

At Berkeley, Keith Davis, observing with a 4-inch refractor, found that no sunspot he could see was blotted out by the moon. All spots were in the region that remained undarkened. At 11:12 PST, near mid-eclipse, a bird was observed to cross the sun's disk slowly.

At Chorrillos (Lima), Peru, Victor A. Estremadoyro observed an eclipse which was nearly annular, as the path of the inverted shadow passed not far from him.

H. Page Bailey and B. C. Parmenter, at their Fairmount solar station, Riverside, Calif., were bothered by wind and dust gusts, but established first contact at 10:01.5 PST, maximum at 11:19, and last contact at 12:38. All their photographs, made with a special camera, came out satisfactorily.



THE ORBITS OF THE SATELLITES OF SATURN

The portion of the **American Ephemeris** chart of Saturn's satellites reproduced here has south at the top as for an inverting telescope. Tethys, magnitude 10.5, is innermost; then Dione, 10.7; Rhea, 10.0; and Titan, 8.3. Their synodic periods are 1d 21h.3, 2d 17h.7, 4d 12h.5, and 15d 23h.3, respectively.

Eastern elongation points are marked 0d, and some of the times (GCT) when the satellites occupy them during January are listed below.

Tethys	Dione	Rhea
0d 22h.3	2d 13h.3	3d 15h.5
2 19.6	5 7.0	8 3.8
16 0.6	16 5.6	17 4.5
29 5.6	27 4.2	30 17.6

For any time of observation, apply the interval since the preceding elongation to the intervals marked on the respective orbits. The dashes in the table indicate

CORRECTION

Frederick K. Vreeland, who took the circumpolar star trail picture which appeared on the back cover for November, 1947, writes that the full diagonal of the negative is 50 degrees, and not 25 degrees, as stated in that issue, *In Focus*, page 12.

that one or more elongation times have been omitted.

Titan's brightness makes it readily visible in small telescopes. Times of eastern and western elongations for January are: eastern, 8d 0h.4, 23d 22h.0; western, 15d 16h.5, and 31d 14h.0.

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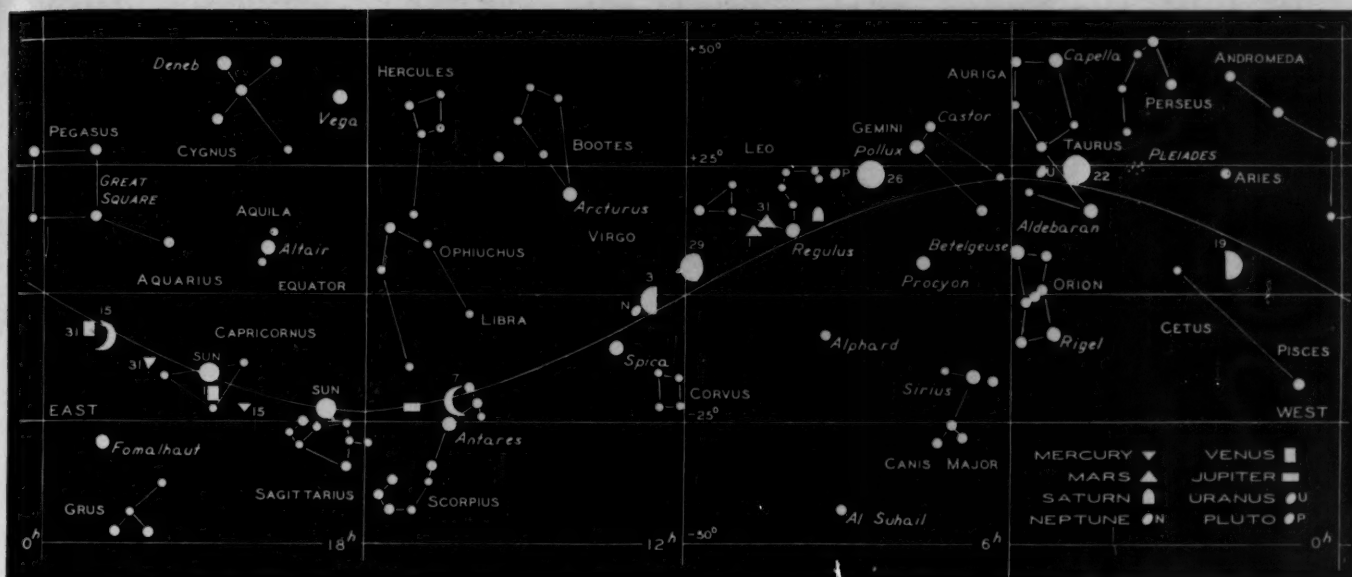
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THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury is in superior conjunction with the sun on January 3rd and moves into the evening sky. Eastern elongation will occur in early February, but during the last week in January, Mercury will set about an hour and a half after the sun. Look for it 18 degrees below Venus, of magnitude -1.

Venus appears as the brilliant object in the western sky shortly after sunset, and will remain visible for nearly three hours by the end of the month. It is located about 30° east of the sun.

Mars reaches a stationary point on January 9th and commences retrograde motion. All month the planet is in Leo, somewhat east of Regulus. Saturn is west of Regulus. This trio rises from four to two hours after sunset. Mars and the moon will be in close conjunction at 5:34 GCT January 28th, the planet just south of the moon. From parts of Canada and the northern states, this is an occultation. (See Occultations.)

CORRECTION: In the December issue, we should have stated that Mars rises 5½ hours after sunset.

VARIABLE STAR MAXIMA

January 14, R Virginis, 6.9, 123307; 21, RR Scorpis, 6.0, 165030a; 23, T Centauri, 6.1, 133633; 26, T Ursae Majoris, 7.9, 123160; 26, R Pegasi, 7.9, 230110; 29, S Gruis, 7.8, 221948. February 3, RT Hydrae, 7.6, 082405.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

Jupiter rises 1½ to three hours before the sun; it is situated northeast of Antares.

Saturn continues its slow retrograde motion in western Leo. The interesting configurations with Mars and Regulus continue during January. See page 78 for a diagram of Saturn's satellites.

Uranus may be found about 3° north of Zeta Tauri, with the aid of binoculars. It is favorably situated for observation the entire night.

Neptune is 25' south of a 5th-magnitude star, 38 Virginis. The planet is 8th magnitude. E. O.

PHASES OF THE MOON

Last quarter January 3, 11:13
New moon January 11, 7:44
First quarter January 19, 11:32
Full moon January 26, 7:11
Last quarter February 2, 0:31

MINIMA OF ALGOL

January 1, 16:06; 4, 12:55; 7, 9:44; 10, 6:33; 13, 3:23; 16, 0:12; 18, 21:01; 21, 17:50; 24, 14:40; 27, 11:29; 30, 8:18. February 2, 5:07.

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Besides the features of No. 3, this model has manually operated slow motion in right ascension, which permits close following of the star under observation.

Model No. 5. TEACHERS' MODEL for Schools \$245.00

This model is well adapted for teaching purposes where the student receives instruction while the telescope follows the star, for an electric motor carries the telescope in approximate sidereal time.

Model No. 6. THE UNIVERSITY MODEL \$550.00

This instrument is driven by a synchronous motor through anti-backlash gearing in sidereal time so accurate as to be within a few seconds of absolute sidereal time per year. It is well suited for photography, and for guiding has slow motion in both axes operated from the eyepiece by flexible shafts.

For telescopes larger than 12 inches, fork-type mountings are suggested. Quotations can be made to fit your requirements.

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OCCULTATION PREDICTIONS

Mars is occulted this month, by a 17-day-old moon, for observers in the northern tier of states and in Canada. Other locations in the United States should witness a very close conjunction, and at places the contact should be grazing. At Station D, near Toronto, the British Nautical Almanac shows grazing. The time of the event is favorable—about midnight in the East, and earlier in the evening toward the West. We shall be glad to receive reports of telescopic observations, especially from those in the borderline regions between close conjunction and definite occultation.

This occultation occurs nearly a month after the moon occulted the star Eta Leonis, December 30th-31st. This star is again occulted in January, but only for observers in the Eastern Hemisphere. Mars will be occulted again on February 24-25th, with predictions given for stations A, B, and D.

January 3-4 m **Virginis** 5.2, 13:38.9 -8:26.5, 23, Im: **A** 11:27.7 -2.2 -0.1 95; **C** 11:19.3 -1.9 -0.4 112; **E** 10:57.9 -1.1 -0.6 135; **F** 11:10.3 +0.4 -3.3 183. Em: **A** 12:35.5 -0.8 -2.0 339; **C** 12:37.5 -1.3 -1.7 325; **E** 12:15.8 -1.6 -0.7 302; **F** 11:58.9 -3.5 +1.5 258; **G** 11:44.9 -0.9 +0.5 293; **I** 11:35.1 -0.9 +1.2 279.

27-28 **MARS** -0.7, 10:34.0 +13:36.0, 17, Im: **A** 5:05.1 ... 195; **B** 4:51.1 -0.6 -2.9 173; **G** 4:15.5 -0.4 -0.4 151; **I** 4:13.0 -0.3 -0.4 151. Em: **A** 5:22.7 ... 224; **B** 5:31.4 -2.2 +2.4 245; **G** 4:58.9 -0.4 +2.2 252; **I** 4:53.8 -0.1 +2.2 249.

January 31-February 1 **Lambda Virginis** 4.6, 14:16.3 -13:08.0, 21, Im: **E** 13:28.7 -2.3 -0.6 79; **F** 13:20.9 -2.3 -1.1 109; **H** 12:32.8 -1.3 -1.0 137. Em: **E** 14:27.9 -1.0 -2.5 341; **F** 14:42.2 -1.5 -2.1 317; **G** 13:45.6 -0.9 -1.2 330; **H** 13:54.4 -2.0 -0.9 298; **I** 13:37.7 -1.1 -0.8 315.

February 2-3 **Delta Scorpii** 2.5, 15:57.3 -22:28.5, 23, Im: **A** 13:47.5 -1.8 -1.3 115; **C** 13:43.6 -1.9 -1.3 122; **E** 13:16.3 -1.7 -1.0 133; **F** 13:22.1 -0.9 -2.5 166; **G** 12:45.2 -0.6 -0.2 147; **I** 12:43.4 +0.1 -0.9 165. Em: **A** 15:07.9 -1.3 -1.4 278; **C** 15:06.5 -1.5 -1.2 274; **E** 14:39.6 -2.1 -0.8 273; **F** 14:23.6 -3.4 +0.7 247; **G** 13:51.4 -1.8 +0.8 265; **I** 13:32.0 -2.1 +1.6 247.

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, GCT, a and b quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	E +91°.0, +40°.0
B +73°.6, +45°.6	F +98°.0, +30°.0
C +77°.1, +38°.9	G +114°.0, +50°.9
D +79°.4, +43°.7	H +120°.0, +36°.0
I +123°.1, +49°.5	

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo - LoS), and multiply b by the difference in latitude (L - LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

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EVENING STARS FOR SOUTHERN OBSERVERS

THIS CHART is prepared for a basic latitude of 30° south, but it may be used conveniently by observers 20 degrees on either side of that parallel. These southern charts appear in alternate months, but always two or three months in advance, to allow time for transmission to observers in any part of the world. The sky is here shown as it appears on March 7th at 11 p.m., March 23rd at 10 p.m., April 7th and 23rd at 9 p.m. and 8 p.m., respectively. Times for other days vary similarly, four minutes earlier per day. These are

local mean times which must be corrected for standard time differences. The 30° horizon is a solid circle; the other horizons are circles, too, those for 20° and 40° south being dashed in part. When facing south, hold "South" at the bottom, and similarly for other directions. Observers in the tropics may find north circumpolar stars on any of our northern star charts. For other charts in this series, see issues of alternate months from March, 1946, to July, 1946; October, 1946, to August, 1947; also September and November, 1947.

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TRACK

TELESCOPE
CAGE

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f 3.3

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PLATFORM

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DIAMETER

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30 FT OPENING

RIGHT
ASCENSION
DRIVE

PASSENGER
ELEVATOR

HOME
BALCONIES

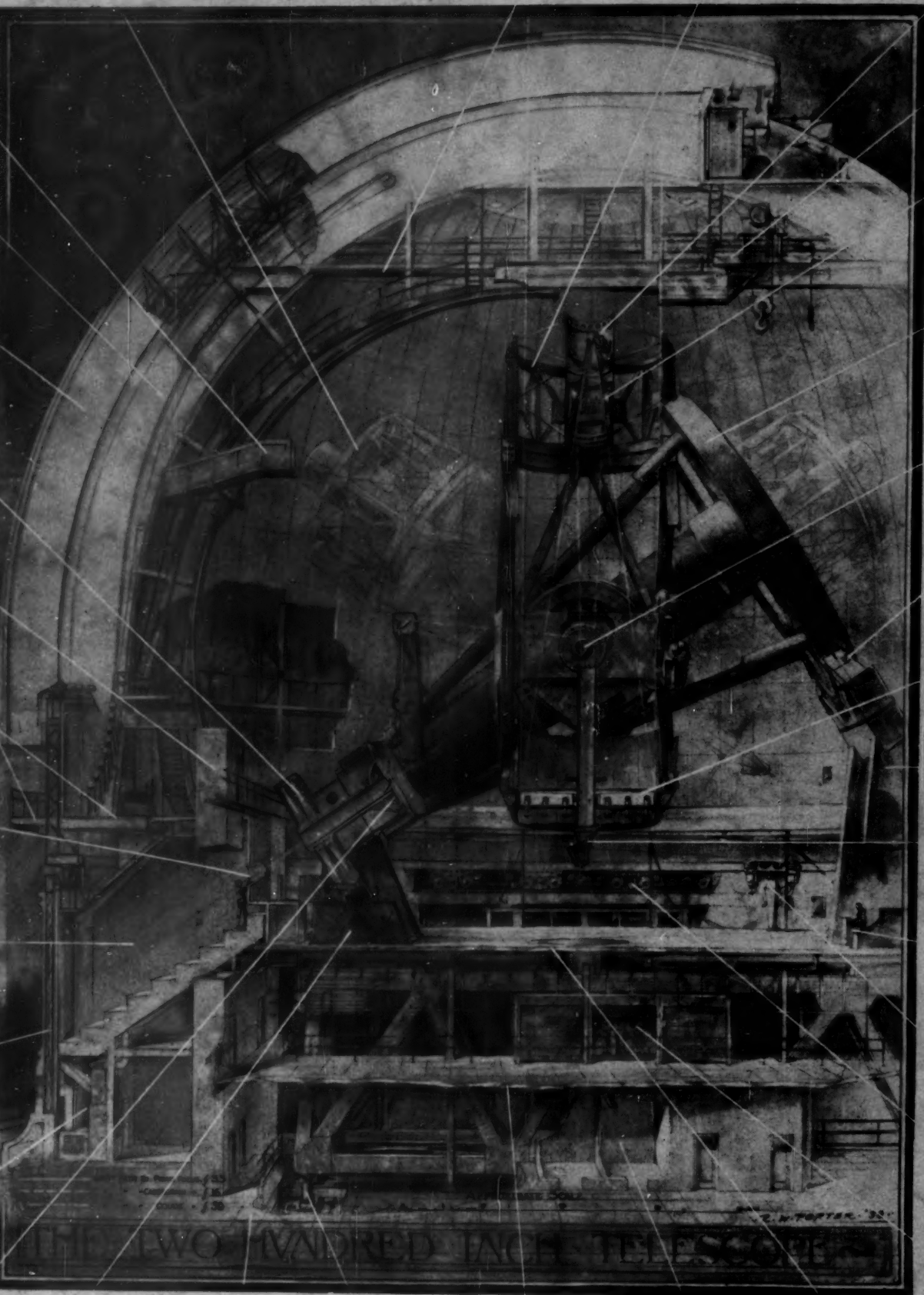
COUDÉ FOCUS
f 30

CONSTANT
TEMPERATURE
ROOM

OBSERVATORY
WALL

AIR
CONDITIONING
DUCTS

SOUTH
POLAR AXIS
BEARING



60 TON C

COUDÉ AN
CASSEGRA
MIRRORS

HORSE SHO
NORTH POL
AXIS BEAR

DECLINATI
ON AXIS

NORTH
PRESSURE
BEARINGS

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